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## Concept Of The Month

Nucleophilic Aromatic Substitution through an Elimination-Addition Mechanism:Benzene

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States of Matter Gases & Liquids

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## Previous Year Questions (NTSE/NSEJS/NSEC/KVPY)

SEPTEMBER 2019

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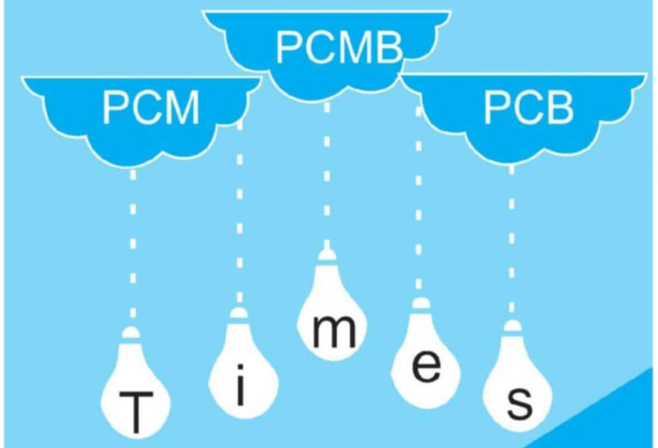
VOL-V





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# Nucleophilic Aromatic Substitution through an Elimination - Addition Mechanism : Benzyne

## Concept of the month

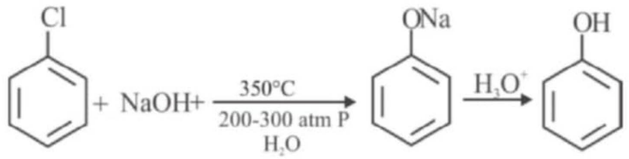
*This column is aimed at preparing students for all competitive exams like JEE, NEET, BITSAT etc. Every concept has been designed by highly qualified faculty to cater to the needs of the students by discussing the most complicated and confusing concepts in Chemistry.*

**By: Arup Kumar Chakravorti (Kolkata)**

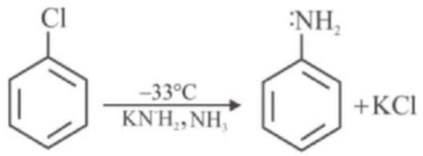
### INTRODUCTION:

Aryl halides such as chlorobenzene and bromobenzene do not react with most nucleophiles under normal conditions, they do react under drastic conditions.

Chlorobenzene can be converted into phenol by treating 6-8% NaOH at 350°C in a presurized reaction.




But chloro benzene reacts with very powerful base, $\overset{\ominus}{N}H_2$ in liquid ammonia and forms aniline as follows



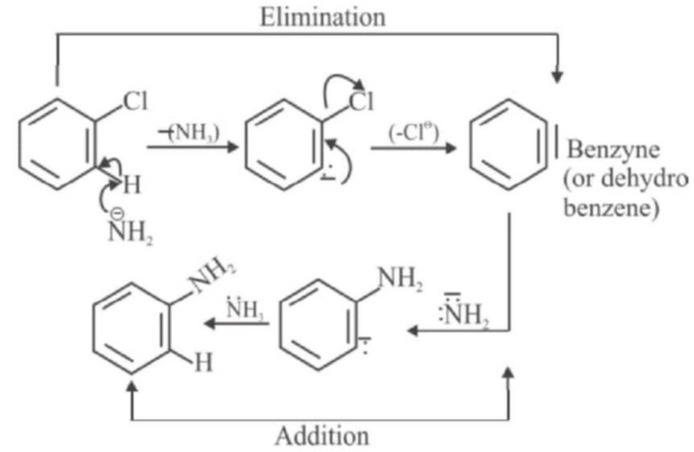

These reactions take place through an elimination addition mechanism that involves the formation of an interesting intermediate called benzyne which may be regarded as the aromatic counter part of acetylene or in other words, it is benzene absence of two ortho hydrogens and may be regarded as dehydrobenzene.

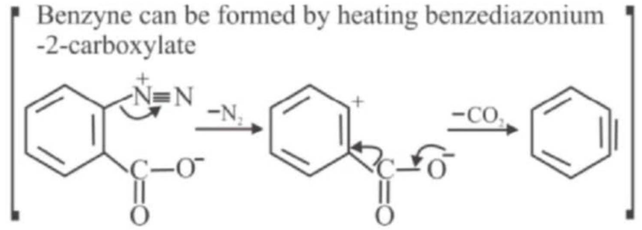
**Mechanism:** In the first step, the amide ion initiates an elimination by the abstracting one of the ortho protons because they are the most acidic. The negative charge which in developed on the ortho position gets stabilized by the inductive effect of the chlorine and chloride ion is lost. A highly reactive intermediate benzyne is produced. Benzyne then reacts with any available nucleophile by a two step addition to produce aniline.



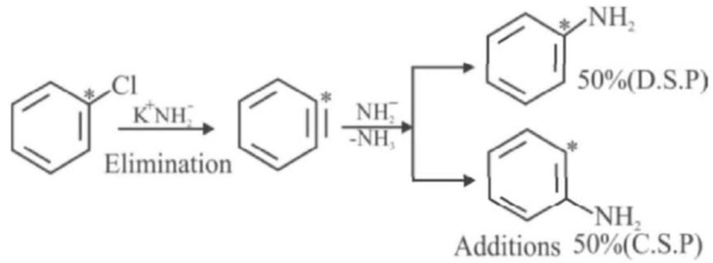


### The Benzyne Elimination-Addition Mechanism

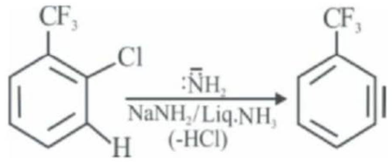


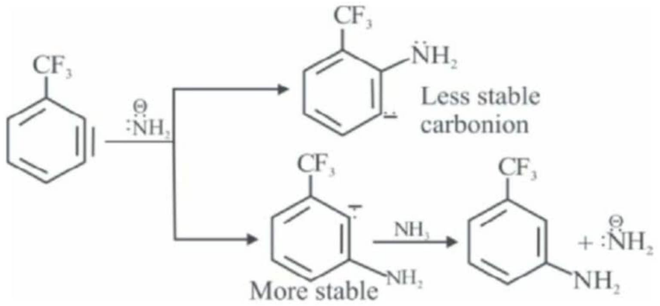




Roberts showed that when $\overset{14}{C}$– labeled chloro benzene is treated with amide ion in liquid ammonia, then aniline that is produced has the label equally divided between 1 and 2 positions. The above shown mechanism i.e., elimination addition is supported by this experiment.

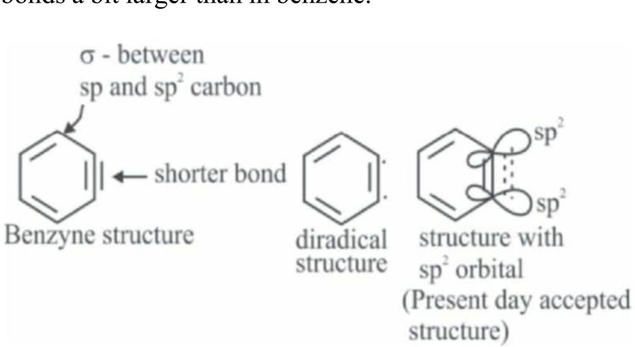



D.S.P = Direct substitution product
C.S.P = Cine substitution product
(When aromatic nucleophilic substitution occurs at a different position, called Cine substitution)
When ortho derivative of chloro benzene is treated amide, the only one organic product in m-(trifluoro methyl) aniline.



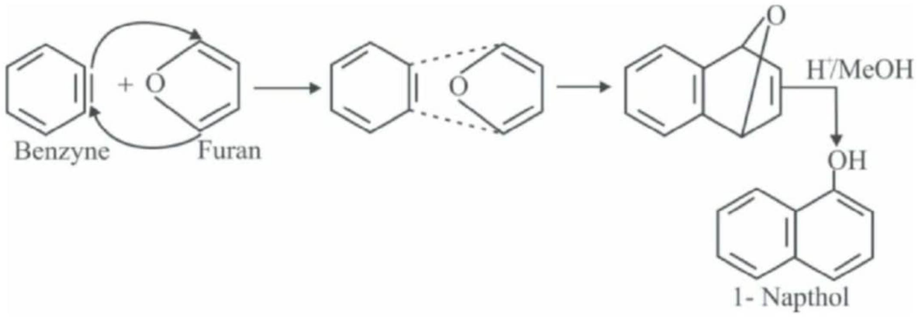




**Structure of Benzyne:** Benzynes are neutral intermediates. In Benzyne structure the third bond is weak and is formed by the overlap of two $sp^2$ hybridised orbitals. The strain energy of benzyne is estimated to be 63 Kcal/mole. In Benzyne two of it's adjacent carbon atoms have free $sp^2$ orbitals. One on each, to form a weak bond by lateral overlaping. Consequently one of C-C bonds a least shorter and adjacent bonds a bit larger than in benzene.




Benzyne itself has been isolated in solid argon at 8K and much evidence for the existence of arynes has come from traping experiments and spectroscopy. Proof of benzynes intermediate is shown by the following reactions.

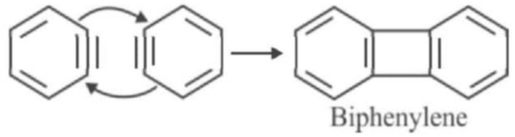
**1.**



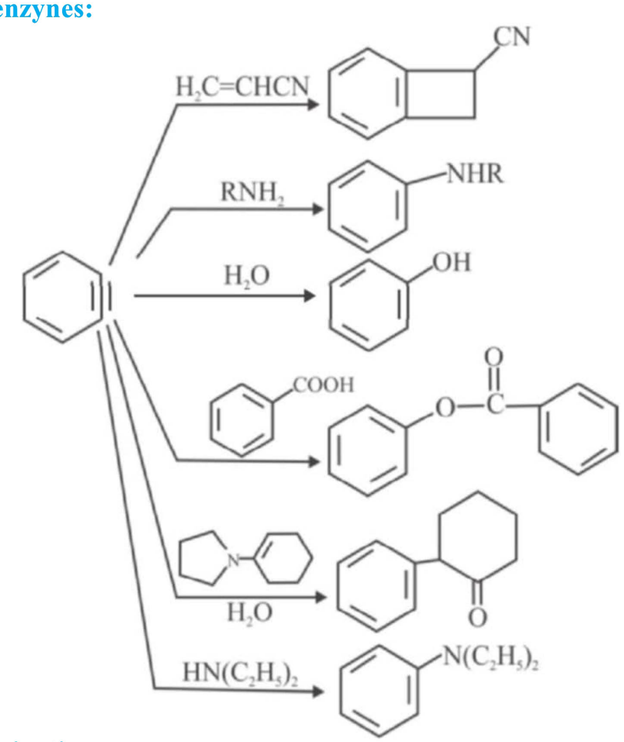





**2.** Benzynes dimerises by (self traping ) to the stable biphenylene.



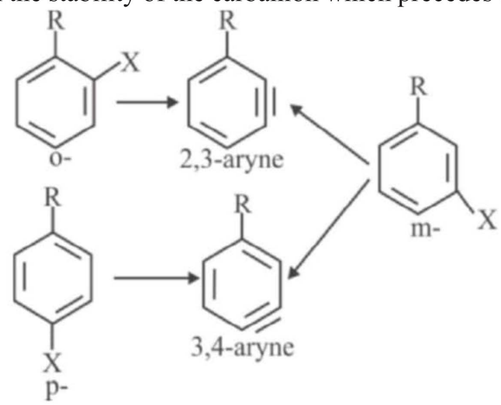

**Reactions of Benzynes:**



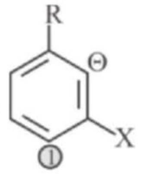
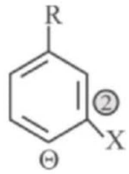

**Direction of elimination:**

$$RC_6H_4X \xrightarrow[\text{In Liq } NH_3]{KNH_2} RC_6H_4NH_2$$

The o- and p- halides can each give only one aryne but the m-halide can give both and which pre dominates depends on the stability of the carbanion which precedes the aryne.

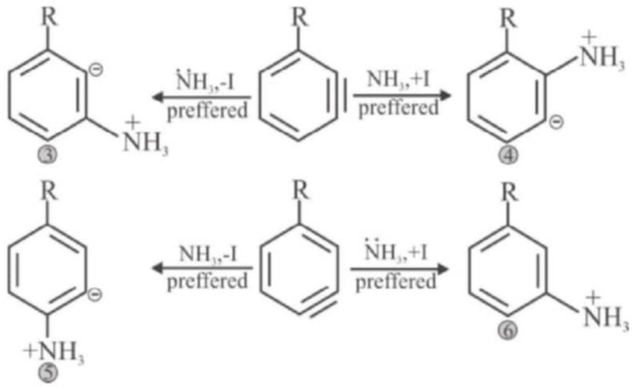


The stability depends on two factors:

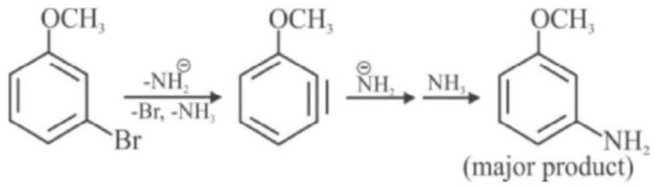
(i) If R is electron withdrawing group (-I. Effect) then  is more stable than 

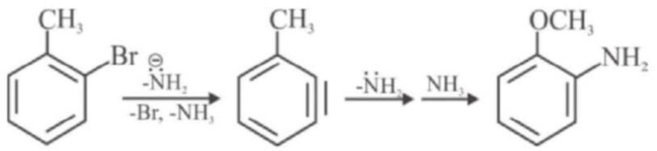
(ii) If R is electron donating group (+I. Effect) 2 is more stable the 1.

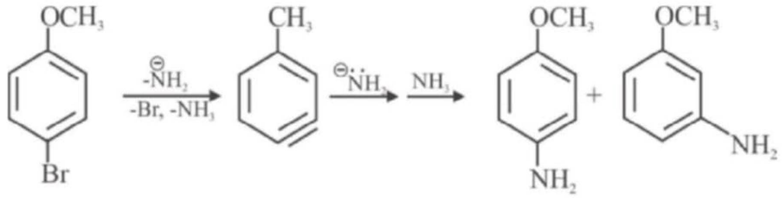
**Direction of addition:**

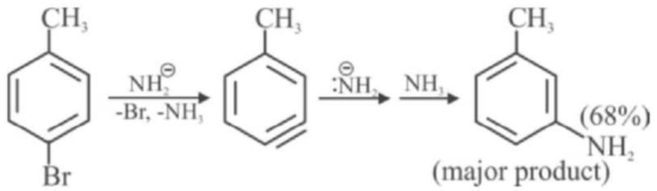



**Examples:**

**1.** 


**2.** 


**3.** 


**4.** 



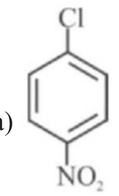


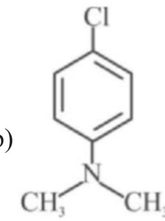

## Exercise

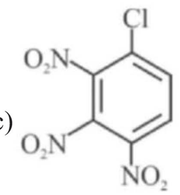
**1.** When o-Bromo fluoro benzene is treated with Mg generates --------
(a) Mg form the Grignard reagent with Br
(b) Mg form the Grignard reagent with F
(c) Benzyne
(d) No reaction takes place

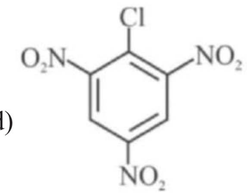
**2.** o- $FC_6H_4OMe \xrightarrow[2.H_2O]{1.PhLi} X + PhH + LiF + LiOH$. Identify the product X.
(a) PhOMe (b) m-$PhC_6H_4OMe$
(c) p-$PhC_6H_4OMe$ (d) o-$PhC_6H_4OMe$

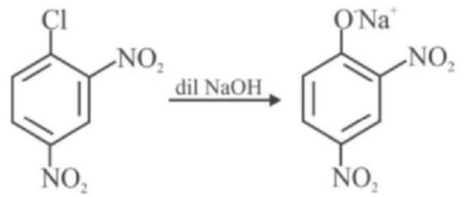
**3.** Which of the following derivatives of benzene would undergo hydrolysis most readily with aq KOH?

(a) 


(b) 

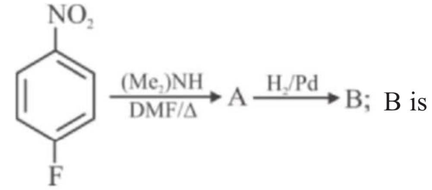

(c) 

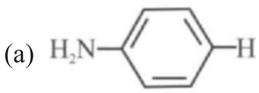

(d) 

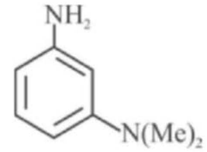

**4.** 

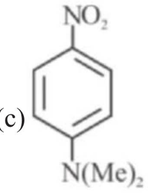

The above transformation proceeds through
(a) Electrophilic addition
(b) Benzyne intermediate
(c) Activated nucleophilic substitution
(d) Elimination, addition mechanism

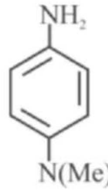
**5.** o-Methoxybromo benzene is treated with sodalime and then with ammonia. The product formed is
(a) o-Methoxyaniline (b) Aniline
(c) Methoxybenzene (d) m-methoxyaniline

**6.** 

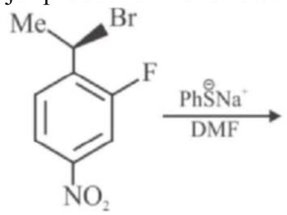

(a) 

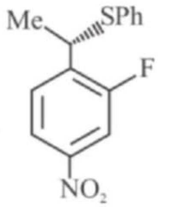

(b) 

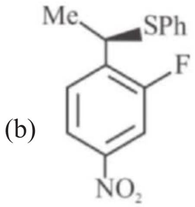

(c) 

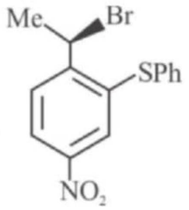

(d) 

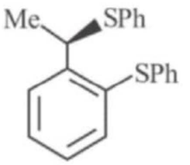

**7.** The major product of the following reaction is



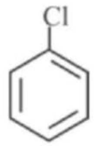

(a) 

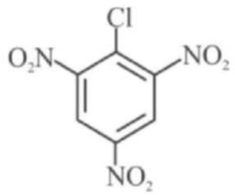

(b) 


(c) 

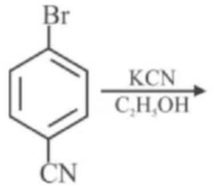

(d) 

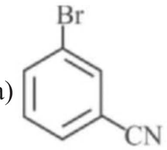
**8.** Which of the following compounds does not form white precipitate with $AgNO_3$?

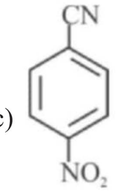
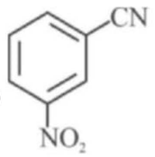
(a) $CH_2 = CH - CH_2 - Cl$ (b) 

(c) $CH_3CH_2 - Cl$ (d) 

**9.** The major product of the following reaction is



(a)  (b) 

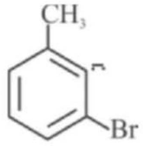
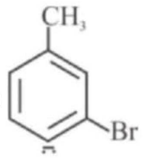
(c)  (d) 

**10.** The number of $\pi$ electrons present in Benzyne is

(a) $7\pi e^-$ (b) $6\pi e^-$

(c) $8\pi e^-$ (d) all are correct

**11.** Which of the following carbanion is more stable?

(a)  (b) 

(c) Both are equally stable

(d) None of the above

**12.** o-Chloro toluidine can undergo

(i) Nucleophilic aliphatic substitution

(ii) Free radical mechanism

(iii) Electrophilic aromatic substitution

(iv) Nucleophilic aromatic substitution

(a) Only (i) (b) (i) and (iv)

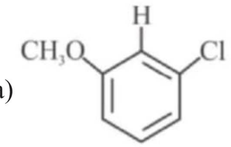
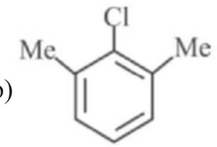
(c) (ii), (iii), (iv) (d) all of the above

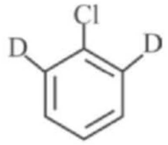
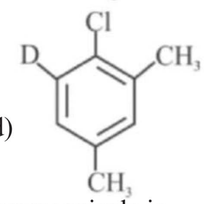
**13.** When m-bromotoluene is treated with amide ion in liquid ammonia the major product is

(a) m-toluidine (b) o-toluidine

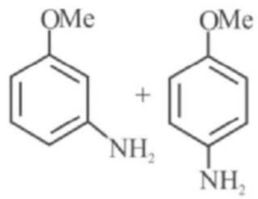
(c) toluidine (d) N-methylaniline

**14.** Which of the following will not undergo benzyne type substitution reaction?

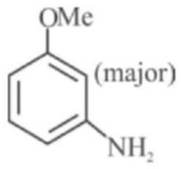
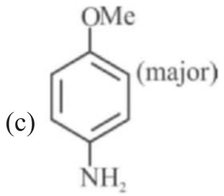
(a)  (b) 

(c)  (d) 

**15.** What happens when m-bromoanisole is treated with $NaNH_2$ is liquid ammonia ?

(a) 

(Both are in equal amount)

(b)  (c) 

(d) None of the above

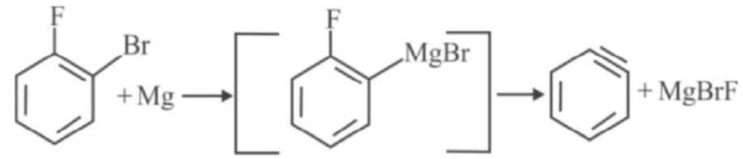




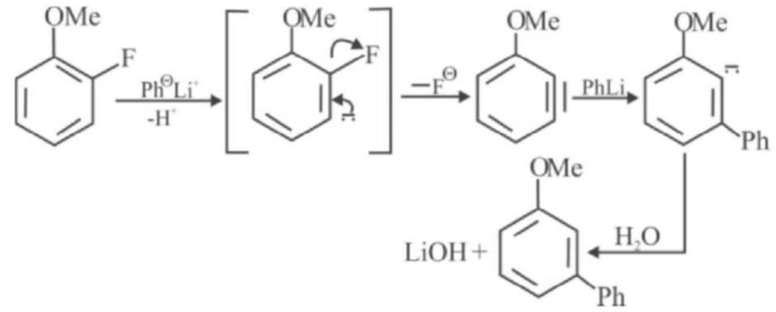
## ANSWER KEY

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **1.** c | **2.** b | **3.** d | **4.** c | **5.** d | **6.** d | **7.** a | **8.** b | **9.** a | **10.** b | **11.** b |
| **12.** c | **13.** a | **14.** b | **15.** b | | | | | | | |

## HINTS & SOLUTIONS

**1.Sol:** 

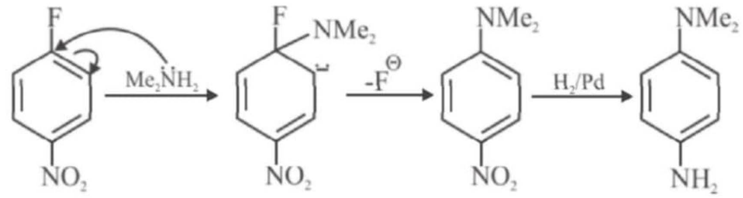
**2.Sol:** The strong base $Ph^-$ abstracts the ortho $H^+$ to F forms methoxybenzyne which reacts with PhLi give the final product as follows

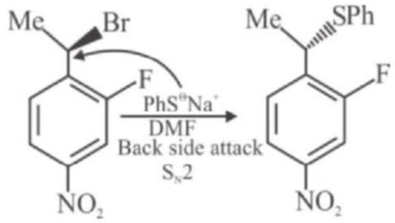


**3.Sol:** Conceptual

**4.Sol:** Electron withdrawing group $-NO_2$ activate the molecule for the nucleophilic substitution reaction and stabilized the intermediate carbanion.

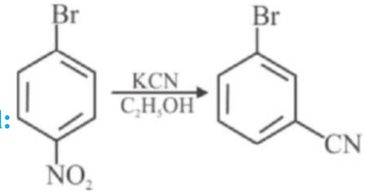
**5.Sol:** Methoxy group is electron with drawing group.

**6.Sol:** 

**7.Sol:** 

**8.Sol:** Due to the formation of double bond between -Cl and phenyl ring due to resonance.

**9.Sol:**

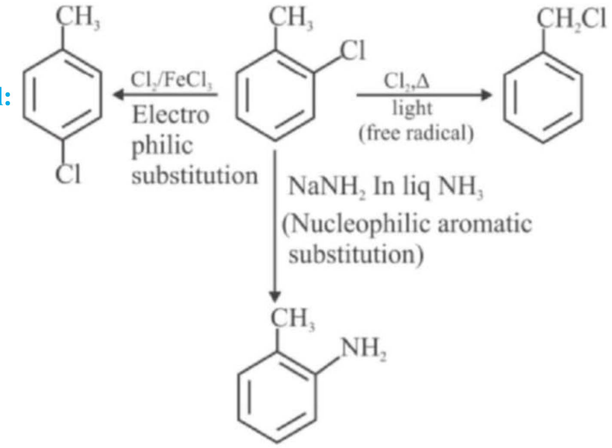



This reaction is nucleophilic substitution with rearrangement and does not occur via an aryne. This is known as von Richter reaction.

**10.Sol:** Conceptual

**11.Sol:** $-CH_3$ group is electron releasing group, the negative charge closer to $-CH_3$ group is unstable.

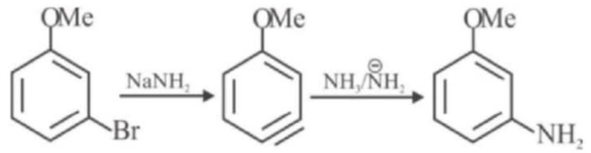
**12.Sol:**




**13.Sol:** $-CH_3$ group have +I effect so m- product is the major product.

**14.Sol:** When both the ortho position of an aryl halide are occupied by alkyl groups, benzyne type substitution reaction do not take place.

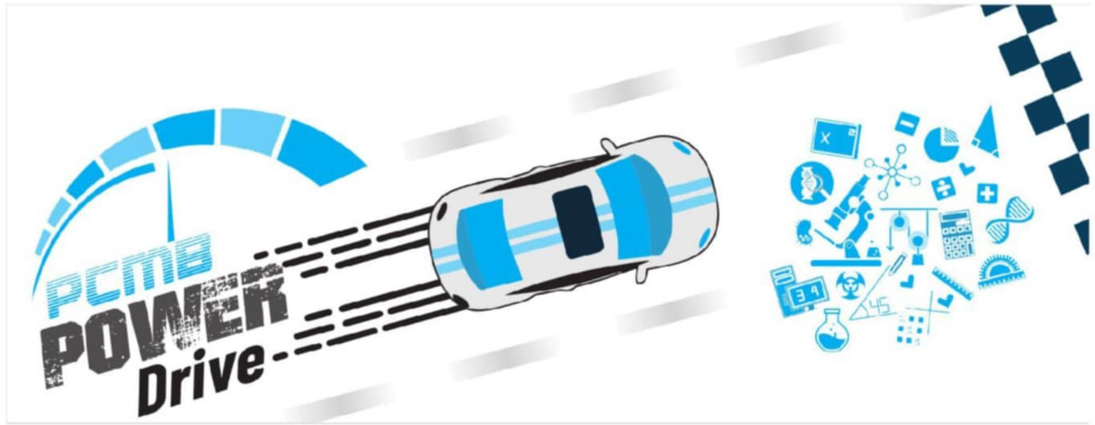
**15.Sol:**










## STATES OF MATTER GASES AND LIQUIDS (CLASS-XI)

### *(1) Introduction of Gaseous State*

- A state of matter in which molecules are far away from each other and free to move in available space is called gaseous state.
- The characteristics of gases are described in terms of four measurable parameters and it is also called as measurable properties of gases which are
  (a) Mass (b) Volume
  (c) Pressure (d) Temperature
- Important unit conversions:
  (a) 1 kg = 1000 g
  (b) $1L = 1000mL = 1000cm^3 = 10^{-3}m^3 = 1dm^3$
  (c) 1atm = 76 cm Hg = 760 mm Hg
  $= 1.013 \times 10^5 N/m^2 = 1.013 \times 10^5 Pa$
  = 1.013 bar = 760 torr.
  (d) $K = {}^\circ C + 273.15$

### *(2) Gas laws*

#### *(I) Boyle's Law*

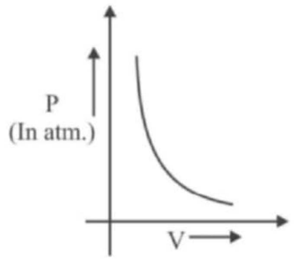
*"At constant temperature, the Pressure of a fixed amount of a gas is inversely proportional to its Volume."*

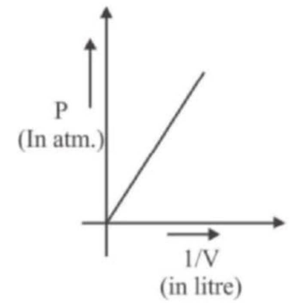
$$P \propto \frac{1}{V} \text{ ( T, n are constant)}$$

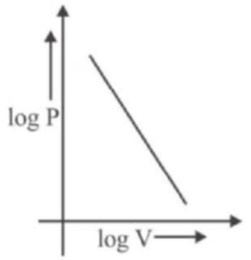
$$P = \frac{k}{V} \text{ or } PV = k \text{ (or) } P_1V_1 = P_2V_2$$

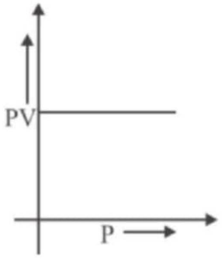
$$\log P = (-1) \log V + \text{Constant (k)}$$

- Graphical representation of Boyle's law:



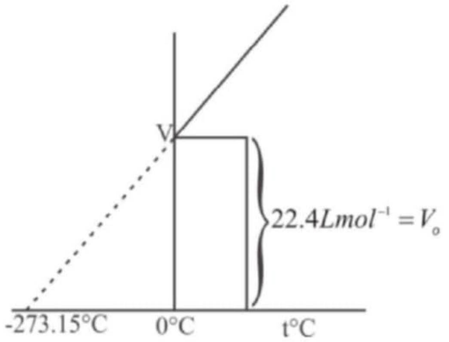






*(II) Charle's law*

V ∝ T ( **P** and **n** are kept constant)

$V = kT$ or $\frac{V_1}{T_1} = \frac{V_2}{T_2}$




*(III) Gay-Lussac's law*

P α T (V and n are kept constant)

$P = kT$ or $P/T = k$ or $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

*(IV) Avogadro's law*

V α n (T and P are constant).

$\frac{V}{n} = \text{cont.}$ or $\frac{V_1}{n_1} = \frac{V_2}{n_2}$

*(V) Ideal gas equation*

- It relates to four parameters of the gas
- Ideal gas equation is, PV = nRT

$$PV = \frac{wRT}{M}$$

Where P is Pressure of the gas (in atm), V is volume of the gas (in L), n is the number of moles of the gas (n = w/M), w is weight of the gas, M is the molecular mass of the gas, T is temperature of the gas (in K), and R is known as Universal gas constant.

- *Values of 'R' (in different units)*

  $0.0821\ L\ atm\ mol^{-1}K^{-1}$

  $8.314\ J\ mol^{-1}K^{-1}$

  $1.98\ cal\ mol^{-1}K^{-1}$

- $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

- $PM = \frac{wRT}{V} = dRT$

Where M is the molecular mass of the gas and d is the density of the gas

*(VI) Dalton's law of partial pressure*

*"The total pressure of a mixture of non-reacting gases is equal to the sum of their partial pressures of component gases".*

$P_T = P_1 + P_2 + ..... + P_n$

- **Partial pressure** of a gas in a mixture is defined as the pressure which the gas would exert if it is allowed to occupy the whole volume of the mixture at the same temperature.
- The partial pressure of a particular gas in mixture can be calculated as follows:

$$p_1 = X_1 P_T$$

Where, $p_1$ is the partial pressure of a particular gas (1)

$X_1$ is the mole fraction of gas (1) and

$P_T$ is the total pressure of the gas mixture

- When a gas is collected over water, it also gets saturated with water vapours. The pressure exerted by water vapours is called **Aqueous Tension**.

The pressure of the dry gas is calculated as follows:

$p_{dry\ gas} = p_{wet\ gas}$ - Aqueous Tension

- The law is valid only for gases which do not combine with each other under normal conditions

*(VII) Graham's law of diffusion:*

"The rate at which a gas diffuses is inversely proportional to the square root of molecular weight (M) or density (d) of the gas"

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{VD_2}{VD_1}} = \sqrt{\frac{M_2}{M_1}}$$

$\frac{r_1}{r_2} = \frac{P_1}{P_2}\sqrt{\frac{M_2}{M_1}}$ at constant T only.

(P is pressure)

$\frac{V_1}{t_1} \times \frac{t_2}{V_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$

(V is volume and t is time)

$\frac{n_1}{t_1} \times \frac{t_2}{n_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$

('n' is no. of moles)

*Applications of graham's law of diffusion:*

- To the detection of marsh gas in mines.
- Separation of isotopes
- Determination of density and molecular mass of gases.

## *(3) The Kinetic molecular theory of gases*

- According to this theory, the volume occupied by the molecules is negligible in comparison to the total volume of the gas. All collisions are perfectly elastic. There is no force of attraction or repulsion amongst the molecules.
- The Average kinetic energy ($\mathbf{E_k}$) is directly proportional to the absolute temperature of the gas.

$$\mathbf{E_k} \propto T$$

- $PV = \frac{1}{3}mnC^2$ (Kinetic gas equation)

Where, P is the pressure exerted by the gas, V is the volume of the gas, m is the average mass of each molecule, n is the no. of molecules and C is the root mean square (rms) velocity of the gas.

- Kinetic energy per mole of the gas:

$$E_k = \frac{3}{2}RT$$

- Kinetic energy per molecule of the gas:

$$E_k = \frac{3}{2}kT$$

Where, k is known as Boltzmann's constant = $R/N_A = 1.38 \times 10^{-23}$ J/K

## *(4) Molecule speeds of gas molecules*

*(I) Root mean square speed (C or $U_{rms}$):*

$$U_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3P}{d}}$$

$$= 1.58 \times 10^4 \times \sqrt{\frac{T}{M}} cm.\sec^{-1}$$

$$= 1.085 \times Average\ speed$$

*(II) Average speed* ($U_{AV}$):

$$U_{AV} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8PV}{\pi M}} = \sqrt{\frac{8P}{\pi d}}$$

*(III) Most probable speed:*

$$U_{MP} = \sqrt{\frac{2RT}{M}} = \sqrt{\frac{2PV}{M}} = \sqrt{\frac{2P}{d}}$$

$$= 0.8166 \times RMS\ speed$$

- Relation between $U_{rms}, U_{av}$ and $U_{mp}$ :

$$U_{rms} : U_{av} : U_{mp} = 1 : 1.128 : 1.224$$

## *(5) Real gases*

- The gases that obey the gas laws under all conditions of pressure and temperature are called ideal gases.
- All gases are real gases and show deviation from the ideal behaviour at high pressure and low temperature.
- *Explanation of deviation from ideal gas behaviour:*

  Kinetic theory of gases do not hold good at all condition mostly these two assumptions

  (I)The force of attraction between gaseous molecules are negligible

  (II)The volume occupied by the gaseous molecules is negligible compared to total volume of gas at high pressure.

## *(6) Vander Waals' equation*

The behavior of real gases can be explained by using Van der Waal's equation given below:

$\left(P + an^2/V^2\right)(V - nb) = nRT$ for 'n' moles of gas

- **'a'** is the measure of magnitude of intermolecular forces of attraction **'b'** is the measure of excluded volume. 'a' and 'b' are known as *Vander Waal's constants.*

*(I) At low pressures*

$$PV = RT - \frac{a}{V}$$

*(II) At extremely low pressure*

PV = RT

*(III) At high pressures*

PV = RT + Pb

## (7) Compressibility Factor (Z)

$$Z = PV_m^{real} / nRT$$

- $Z = 1$, the gas is ideal at all temperatures and pressures.
- $Z > 1\left(Z = 1 + \frac{Pb}{RT}\right)$, the gas is less compressible than expected from ideal behaviour and shows positive deviation, usually at high pressure. For $H_2$ and He, under all pressures Z > 1.
- $Z < 1\left(Z = 1 - \frac{a}{RTV}\right)$, the gas is more compressible than expected from ideal behaviour and shows negative deviation, usually at low *P.*
- **Boyle Temperature($T_b$):** The temperature at which real gas behaves like as an ideal gas is known as Boyle temperature.

$$T_b = \frac{a}{bR}$$

## (8) Liquefaction of gases

- Principle :

(I) When temperature of gas is lowered, the voulme of gas and also the K.E of molecules decreases. Molecular motion becomes slow, attractive forces increase and the molecules come closer and then gas changes to liquid.

(II) When Presssure of gas is increased the volume of gas decreases because molecules move closer resulting increased attractive forces where gas is forced to change into liquid.

## (9) Critical constants

*(I) Critical Temperature* $(T_c)$:

The temperature below which the gas can be liquified by application of pressure alone is critical temperature.

$$T_c = \frac{8a}{27bR}$$

*(II) Critical Pressure (P):*

The pressure required to liquify a gas at $T_c$ is called critical pressure.

$$P_c = \frac{a}{27b^2}$$

*(III) Critical Volume* $(V_c)$:

The volume occupied by one mole of the substance at $T_c$ & $P_c$ is $V_c$.

$$V_c = 3b$$

- Relation between critical constants:

$$\frac{P_c V_c}{T_c} = \frac{3}{8}R$$

## (10) Joule-Thomson effect

- "Cooling of gas by expansion from high pressure side to low pressure is called "Joule -Thomson effect". Cooling is due to the fact that internal work is done by the gas in overcoming the attractive forces between the gas molecules.
- The temperature below which if a gas is allowed to expand, it causes cooling effect and above which the gases get heated on expansion is known as *Inversion temperature* $(T_i)$.

$$T_i = \frac{2a}{Rb}$$

## (11) Liquid state

*(I) Evaporation*

The process of escape of molecules spontaneously from the surface of a liquid is called evaporation.





- The liquids with hydrogen bonding are less volatile & changes with degree of hydrogen bonding. The rate of evaporation depends inversely on the strength of the intermolecular forces.

*(II) Vaporisation*

- The conversion of a liquid into its vapour at its boiling point is called vaporisation.

(i) Vapour pressure

The pressure exerted by vapours when there is an equilibrium state between the liquid phase and vapour phase is called equilibrium vapour pressure (or) saturated vapour pressure.

*(III) Surface Tension*

- The force acting along the surface of a liquid at right angles to any line of 1 unit length is known as surface tension.
- SI unit for surface tension is $Nm^{-1}$. Surface tension of liquids decreases with a rise in temperature almost linearly. Surface tension at $T_C$ for any liquid is zero.

*(IV) Viscosity*

The measure of resistance to the flow of the layers of liquid.

$$\therefore F = \eta A.\frac{du}{dz}$$

here $\eta$ - Proportionality Constant (or) Coefficient of Viscosity.

- SI unit for $\eta$ is $Nm^{-2}S$ or PaS.
- Hydrogen bond and vander Waals forces cause high viscosity. Glass is an extremely viscous liquid.
- As the temperature increases, viscosity decreases since kinetic energy of molecules increases that overcome the intermolecular forces.

## Exercise

1. The intermolecular force of attraction present in $C_6H_6$ are
   (a) Dipole - Dipole
   (b) Ion - dipole
   (c) Dipole - induced dipole
   (d) Dispersion
2. The melting point of four substances are given in bracket then the attraction forces in a solid is more in case of
   (a) Ice (273 K)
   (b) NaF (1270 K)
   (c) Phosphorous (317K)
   (d) Naphthalene(353K)
3. Which of the following indicates Charle's law mathematically (when n,P are constant)?
   (I) VT = constant
   (II) $V_t = V_0\left(1 + \frac{t}{273}\right)$
   (III) $V_0 = V_t\left(1 + \frac{t}{273}\right)$
   (IV) V/T = constant(k)
   (a) I, IV (b) I, II (c) II, III (d) II, IV
4. A vessel of 120 mL capacity contains a certain amount of gas at 35 °C and 1.2 bar pressure. The gas is transferred to another vessel of volume 180 mL at 35°C. What would be its pressure(in bar)?
   (a) 0.6 (b) 0.8 (c) 1.0 (d) 1.8
5. At a constant temperature, what should be the percentage increase in pressure for a 5% decrease in the volume of gas ?
   (a) 5% (b) 10% (c) 5.26% (d) 4.26%
6. The value of the universal gas constant R depends upon the
   (a) Nature of the gas
   (b) Mass of the gas
   (c) Temperature of the gas
   (d) Units of measurement
7. The weight of $CH_4$ in a 9 litre cylinder at 16 atm and $27°C$ is (R = 0.0821 L atm $mol^{-1}K^{-1}$)
   (a) 93.5 gm (b) 86 gm
   (c) 80 gm (d) 105 gm
8. The density of a gas is 2.5g/L at 127ºC and 1 atm. The molecular weight of the gas is
   (a) 82.1 (b) 41.05 (c) 56 (d) 28
9. $N_2 + 3H_2 \rightarrow 2NH_3$. 1 mole of $N_2$ and 4 moles of $H_2$ are taken in 15 L flask at 27°C.

After complete conversion of $N_2$ into $NH_3$, 5L of water is added. Pressure set up in the flask is

(a) 4.926 atm (c) 3.284 atm
(c) 1.643 atm (d) 2.463atm

**10.** What is the pressure of a mixture of 1g of dihydrogen and 1.4 g of dinitrogen stored in a 5 litre vessel at $127°C$?

(a) 5.50 (b) 3.61 (c) 4.40 (d) 2.50

**11.** If $10^{-3}\,dm^3$ of water is introduced into a $1.0 dm^3$ flask at 300 K, then how many moles of water are in the vapour phase when equilibrium is established?

(Given vapour pressure of $H_2O$ at 300 K is 3170 Pa; $R = 8.314\ JK^{-1}mol^{-1}$)

(a) $5.56\times10^{-3}\ mol$ (b) $1.53\times10^{-2}\ mol$

(c) $4.46\times10^{-2}\ mol$ (d) $1.27\times10^{-3}\ mol$

**12.** A and B are ideal gases. The molecular weights of A and B are in the ratio of 1 : 4. The pressure of a gas mixture containing equal weights of A and B is P atm. What is the partial pressure (in atm) of B in the mixture?

(a) P/5 (b) P/2 (c) P/2.5 (d) 3P/4

**13.** If three unreactive gases having partial pressures $P_A, P_B$ and $P_C$ and their moles are 1, 2 and 3 respectively then their total pressure will be

(a) $P = P_A + P_B + P_C$ (b) $P = \dfrac{P_A + P_B + P_C}{6}$

(c) $P = \dfrac{\sqrt{P_A + P_B + P_C}}{3}$ (d) None of these

**14.** 2.8 g of $N_2$, 2.8 g $CO$, and 4.4 g $CO_2$ are found to exert a pressure of 700 torr. Find partial pressure of $N_2$ gas in the mixture.

(a) 280.8 torr (b) 233.3 torr
(c) 300 torr (d) 350 torr

**15.** The densities of $CH_4$ and $O_2$ are in the ratio 1 : 2. The ratio of rates of diffusion of oxygen and methane is

(a) 1.414 : 1 (b) 1 : 1.414
(c) 1.732 : 1 (d) 1 : 1.732

**16.** A balloon filled with ethyne is pricked with a sharp point and quickly dropped in a tank of $H_2$ gas under identical conditions. After a while the balloon will

(a) shrink
(b) enlarge
(c) completely collapse
(d) remain unchanged in size

**17.** A '$V$' $dm^3$ flask contains gas A and another flask of $2V\ dm^3$ contains gas B at the same temperature. If density of gas A is $3.0\ g\ dm^{-3}$ and of gas B is $1.5\ g\ dm^{-3}$ and molecular weight of A is half of the molecular weight of B, then the ratio of pressure exerted by gases is

(a) $\dfrac{P_A}{P_B} = 2$ (b) $\dfrac{P_A}{P_B} = 1$

(c) $\dfrac{P_A}{P_B} = 4$ (d) $\dfrac{P_A}{P_B} = 3$

**18.** Under identical conditions which of the following has maximum diffusion rate?

(a) $Cl_2$ (b) $H_2$ (c) $CO_2$ (d) $O_2$

**19.** Rate of diffusion of a gas is 720 mL per minute. But the gas diffused for 20 seconds only. The volume of the gas diffused in 'mL' is

(a) 240 (b) 120 (c) 60 (d) 30

**20.** The reaction between gaseous $NH_3$ and HBr produces a white solid $NH_4Br$. Suppose that $NH_3$ and HBr are introduced simultaneously into the opposite ends of an open tube of 1 metre long. Where would you expect the white solid to form? (Atomic mass of Br = 80)

(a) At a distance of 34.45 cm from $NH_3$ end
(b) At a distance of 68.5 cm from $NH_3$ end
(c) At a distance of 44.45 cm from HBr end
(d) At a distance of 45.45 cm from HBr end

**21.** Which is wrong according to Kinetic theory of gases?

(a) The average K.E. of the molecules is directly proportional to the absolute temperature.
(b) All the molecules in a gas have the same K.E.
(c) Collisions between molecules are perfectly elastic
(d) Pressure is due to the impact of the molecules on the walls of the container

**22.** The temperature at which methane molecules have the same average kinetic energy as that of oxygen molecules at 27ºC is

(a) 327ºC (b) 27ºC (c) 927ºC (d) 627ºC

**23.** The average speed at temperature $T°C$ of $CH_4(g)$ is $\sqrt{\dfrac{28}{88}}\times10^3\ ms^{-1}$. What is the value of T?

(a) $24055°C$ (b) $-32.45°C$
(c) $3000°C$ (d) $-24.055°C$

**24.** The root mean square velocity of hydrogen is $\sqrt{5}$ times than that of nitrogen. If T is the temperature of the gas, then:

(a) $T_{H_2} = T_{N_2}$ (b) $T_{H_2} > T_{N_2}$

(c) $T_{H_2} < T_{N_2}$ (d) $T_{H_2} = \sqrt{7}\ T_{N_2}$

**25.** At what temperature will the average speed of $CH_4$ molecules have the same value as $O_2$ has at 300 K ?

(a) 1200 K (b) 150 K
(c) 600 K (d) 300 K

**26.** Which one of the following is the wrong assumption of kinetic theory of gases?

(a) Momentum and energy always remain conserved.
(b) Pressure is the result of elastic collision of molecules with the container's wall.
(c) Molecules are separated by great distances compared to their sizes.
(d) All the molecules move in straight line between collision and with same velocity.

**27.** A gaseous mixture contains 4 molecules with a velocity of $6\ cm\ s^{-1}$, 5 molecules with a velocity of $2\ cm\ s^{-1}$ and 10 molecules with a velocity of $3\ cm\ s^{-1}$. What is the RMS velocity of the gas?

(a) $2.5\ cm\ s^{-1}$ (b) $1\ cm\ s^{-1}$
(c) $3.6\ cm\ s^{-1}$ (d) $6\ cm\ s^{-1}$

**28.** The rms speed of $N_2$ molecules in a gas is u. If the temperature is doubled and the nitrogen molecules dissociate into nitrogen atoms, the rms speed becomes

(a) u/2 (b) 2u (c) 4u (d) 14u

**29.** The average velocity and RMS velocity for a group of six particles having speeds 11.2, 9.0, 8.3, 6.5, 3.7 and 1.8 $ms^{-1}$ are, respectively

(a) $6.75\ ms^{-1}, 7.47\ ms^{-1}$
(b) $7.47\ ms^{-1}, 6.75\ ms^{-1}$
(c) $7.65\ ms^{-1}, 8.47\ ms^{-1}$
(d) None of these

**30.** A gas is said to behave like an ideal gas when the relation PV/T = constant. When do you expect a real gas to behave like an ideal gas?

(a) when the temperature is low
(b) when both the temperature and pressure is low
(c) when both the temperature and pressure are high
(d) when the temperature is high and pressure is low

**31.** Pressure exerted by 1 mole of methane in a 0.25 litre container at 300 K using van der Waal's equation (given,a = 2.253 atm $lit^2mol^{-2}, b = 0.0428\ lit\ mol^{-1}$) is

(a) 82.82 atm (b) 152.51 atm
(c) 190.52 atm (d) 70.52 atm

**32.** Boyle's law, according to kinetic equation can be expressed as

(a) PV = kT (b) PV = RT

(c) $PV = \dfrac{3}{2}kT$ (d) $PV = \dfrac{2}{3}kT$

**33.** Maximum deviation from ideal gas is expected from

(a) $N_2(g)$ (b) $CH_4(g)$

(c) $NH_3(g)$ (d) $H_2(g)$

**34.** Positive deviation from ideal behaviour takes place because of
(a) molecular interaction between atoms and $PV / nRT > 1$
(b) molecular interaction between atoms and $PV / nRT < 1$
(c) finite size of atoms and $PV / nRT > 1$
(d) finite size of atoms and $PV / nRT < 1$

**35.** The deviation from the ideal gas behaviour of a gas can be expressed as

(a) $Z = \frac{P}{VRT}$ (b) $Z = \frac{PV}{nRT}$

(c) $Z = \frac{nRT}{PV}$ (d) $Z = \frac{VR}{PT}$

**36.** Which of the following are correct statements?
(a) Van der Waal's constant "a" is a measure of attractive force.
(b) Van der Waal's constant "b" is also called co-volume or excluded volume.
(c) b is expressed in L $mol^{-1}$
(d) All of the above

**37.** The relationship between $P_c$, $V_c$ and $T_c$ is
(a) $P_cV_c = RT$ (b) $P_cV_c = 3RT_c$

(c) $P_cV_c = \frac{3}{5}RT_c$ (d) $P_cV_c = \frac{3}{8}RT_c$

**38.** Gases X, Y, Z, P and Q have the van der Waals' constant a and b (in CGS units) as shown below:

| Gases | X | Y | Z | P | Q |
|---|---|---|---|---|---|
| *a* | 6 | 6 | 20 | 0.05 | 30 |
| *b* | 0.025 | 0.15 | 0.1 | 0.02 | 0.2 |

The gas with the highest critical temperature is
(a) P (b) Q (c) Y (d) X

**39.** Among the following, the incorrect statement is:
(a) At low pressure, real gases show ideal behaviour
(b) At very low temperature, real gases show ideal behaviour.
(c) At very large volume, real gases show ideal behaviour.
(d) At Boyle's temperature, real gases show ideal behaviour.

**40.** Which among the following has lowest surface tension?
(a) Hexane (b) water
(c) $CH_3OH$ (d) $CH_3CH_2OH$

**41.** A drop of oil is placed on the surface of water. Which of the following statements is correct?
(a) It will remain on it as a sphere
(b) It will spread as a thin layer
(c) It will be partly as spherical droplets and partly as thin film
(d) It will float as a distorted drop on the water surface

**42.** The correct order of viscosity of the following liquids will
(a) Water < methyl alcohol < dimethyl ether < glycerol
(b) methyl alcohol < glycerol < water < dimethyl ether
(c) dimethyl ether < methyl alcohol < water < glycerol
(d) glycerol < dimethyl ether < water < methyl alcohol

**43.** A gas obeys the equation of state $P(V - b) = RT$. The parameter 'b' is a constant. The slope of the isochore is

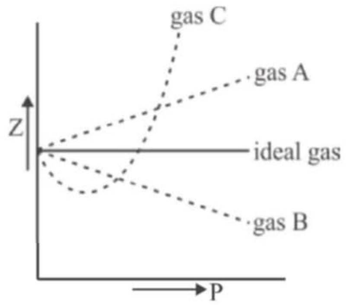
(a) zero (b) -ve (c) $\frac{R}{P}$ (d) $\frac{R}{V-b}$

**44.** The slope of the graph between log V and log T (Kelvin scale), for a given mass of a gas is

(a) +1 (b) -1 (c) $\frac{1}{P}$ (d) $\frac{1}{n}$

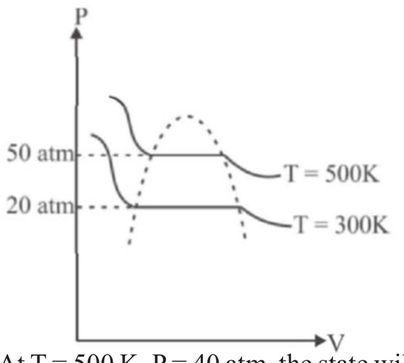
**45.** Which of the following behaviour is true regarding the coefficient of viscosity ($\eta$) of a liquid?
(a) Plot of $\eta$ versus T is non linear
(b) Plot of $\eta$ versus $\frac{1}{T}$ is linear
(c) $\eta = \frac{E}{RT}$
(d) Plot of log $\eta$ versus $\frac{1}{T}$ is non linear

**46.** Refer to the figure given and identify the correct statement.



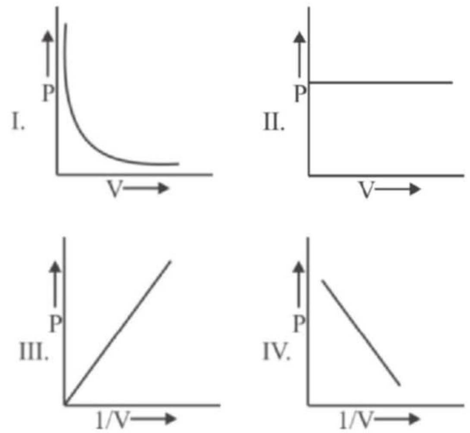

(a) For gas A, a = 0 and Z will linearly depend on pressure
(b) Gas C is a real gas and we can find 'a' and 'b' if intersection data is given
(c) All van der Waal gases will behave like gas C and give positive slope at high pressure
(d) For gas B, b = 0 and Z will linearly depend on pressure (In all options, 'a' and 'b' are Vander Waals constant)

**47.** For a real gas, the P-V curve was experimentally plotted, and it had the following appearance with respect to liquification. Choose the correct statement.



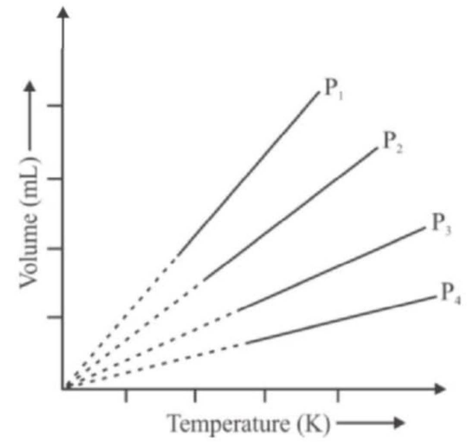

(a) At T = 500 K, P = 40 atm, the state will be liquid
(b) At T = 300 K, P = 50 atm, the state will be gas
(c) At T < 300 K, P > 20 atm, the state will be gas
(d) At 300 K < T < 500 K, P > 50 atm, the state will be liquid

**48.** Which of following graph(s) represents Boyle's law?



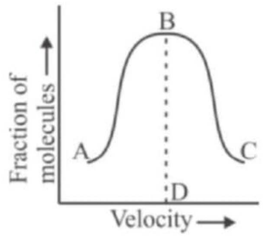

(a) Only I (b) II and IV
(c) I and III (d) Only III

**49.** A plot of volume (V) versus temperature (T) for a gas at constant pressure is a straight line passing through the origin. The plots at different values of pressure are shown in figure. Which of the following order of pressure is correct for this gas?




(a) $P_1 > P_2 > P_3 > P_4$ (b) $P_1 = P_2 = P_3 = P_4$
(c) $P_1 < P_2 < P_3 < P_4$ (d) $P_1 < P_2 = P_3 < P_4$

**50.** In the following graph, the dotted line at stage D represents




(a) $\sqrt{\frac{2RT}{M}}$ (b) $\sqrt{\frac{3RT}{M}}$

(c) $\sqrt{\frac{8RT}{\pi M}}$ (d) $\sqrt{\frac{\pi RT}{8M}}$

## ANSWER KEY

| | | | | |
|---|---|---|---|---|
| **1.** d | **2.** b | **3.** d | **4.** b | **5.** c |
| **6.** d | **7.** a | **8.** a | **9.** d | **10.** b |
| **11.** d | **12.** a | **13.** a | **14.** b | **15.** b |
| **16.** b | **17.** c | **18.** b | **19.** a | **20.** b |
| **21.** b | **22.** b | **23.** b | **24.** c | **25.** b |
| **26.** d | **27.** c | **28.** b | **29.** a | **30.** d |
| **31.** a | **32.** d | **33.** c | **34.** c | **35.** b |
| **36.** d | **37.** d | **38.** d | **39.** b | **40.** a |
| **41.** b | **42.** c | **43.** d | **44.** a | **45.** a |
| **46.** a | **47.** c | **48.** c | **49.** c | **50.** a |

## HINTS & SOLUTIONS

**1.Sol:** Benzene is a non-polar molecule. Between two non-polar molecules, dispersion forces exists.

**2.Sol:** M.P. is directly proportional to stability.

**3.Sol:** conceptual

**4.Sol:** $P_1V_1 = P_2V_2$

$120 \times 1.2 = P_2 \times 180$

$P_2 = 0.8$ bar

**5.Sol:** $V_2 = V_1 - 0.05 \qquad V_1 = 0.95V_1$

By using Boyle's law,

$P_1V_1 = P_2V_2$

$$P_2 = \frac{P_1}{0.95} = 1.0526P_1$$

% Increase

$$= \frac{(P_2 - P_1) \times 100}{P_1} = 0.0526 \times 100 = 5.26\%$$

**6.Sol:** The value of the universal gas constant, R depends upon the units of measurement.

R = 0.0821 L atm $mol^{-1}$ $K^{-1}$

= 8.314 J $mol^{-1}$ $K^{-1}$

= 1.98 cal $mol^{-1}$ $K^{-1}$

**7.Sol:** Given P = 16 atm, V = 9 litre,

T = 300 K, $M_{CH_4} = 16$,

R = 0.0821 L atm $mol^{-1}K^{-1}$

$$PV = \frac{w}{M} \times R \times T$$

$$16 \times 9 = \frac{w}{16} \times 0.0821 \times 300$$

$$w = 93.5\ gm.$$

**8.Sol:** $$P = \frac{dRT}{M}$$

**9.Sol:** $N_2 + 3H_2 \rightarrow 2NH_3$

| | | | |
|---|---|---|---|
| 1 | 4 | 0 | (Before Reaction) |
| 0 | 1 | 2 | (After reaction) |

Since all the ammonia form gets dissolved in water, no.of moles of gas($H_2$) left = 1

Since 5 L water is added to 15 L flask the available volume for 1 mole $H_2$ gas = 10 L

$$P = \frac{1 \times 0.0821 \times 300}{10} = 2.463\ atm\ .$$

**10.Sol:** No. of moles of $H_2 = \frac{1}{2} = 0.5$

$$\left(\text{no. of moles} = \frac{\text{moles}}{\text{molar mass}}\right)$$

No. of moles of $N_2 = \frac{1.4}{28} = 0.05$

$\therefore$ Total no. of moles of gas(n) = 0.5 + 0.05 = 0.55





Using PV = nRT

$$P = \frac{nRT}{V} = \frac{0.55 \times 0.0821 \times 400}{5} = 3.61\ \text{atm.}$$

**11.Sol:** Number of moles,

$$n = \frac{pV}{RT} = \frac{3170 \times 10^{-3}}{8.134 \times 300} = 1.27 \times 10^{-3}\ mol$$

**12.Sol:** $n_A$ = w/1 = w

$n_B$ = w/4

$X_B$ = (w/4) / [w/4 + w] = 1/5

$P_B = X_B\ P_T$ = P/5

**13.Sol:** According to Dalton's law of partial pressure, $P_T = P_A + P_B + P_C$

**14.Sol:** $P_{N_2}$ = Mole fraction $\times$ $P_{total}$

$$= \frac{2.8/28}{\frac{2.8}{28} + \frac{2.8}{28} + \frac{4.4}{44}} \times 700 = \frac{0.1}{0.3} \times 700$$

= 233.3 torr.

**15.Sol:** $$\frac{r_{O_2}}{r_{CH_4}} = \sqrt{\left(\frac{d_{CH_4}}{d_{O_2}}\right)} = \sqrt{\left(\frac{1}{2}\right)}$$

= 1 : 1.414

**16.Sol:** $H_2$ gases diffuses into balloon. Hence, it is enlarged.

**17.Sol:** Using $P = \frac{d}{M}RT$

For gas A, $P_A = \frac{3}{M_A} \times R \times T$

and $P_B = \frac{1.5}{M_B} \times R \times T$

$$\therefore \quad \frac{P_A}{P_B} = \frac{2 \times M_B}{M_A} = \frac{2 \times 2 \times M_A}{M_A} = 4$$

**18.Sol:** Higher is the molecular weight of gas lower is the rate of diffusion.

**19.Sol:** Per 1 min = 60 sec, rate of diffusion is 720 mL.

Per 20 sec, rate of diffusion is

720 x 20/60 = 240 mL

**20.Sol:** $$\frac{\text{Distance from } NH_3 \text{ end}}{\text{Distance from } HBr \text{ end}} = \sqrt{\frac{M_{HBr}}{M_{NH_3}}}$$

Total length of tube = 1 m = 100 cm

Assume that, the distance from $NH_3$ end to white solid = $x$ cm

Distance from $HBr$ end = (100 - $x$) cm

$$\frac{x}{100 - x} = \sqrt{\frac{81}{17}}$$

On solving, we get $x$ = 68.5 cm

**21.Sol:** All the molecules in a gas have the different K.E.

**22.Sol:** K.E. depends on temperature but on the nature of the gas

**23.Sol:** $$\sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{28}{88}} \times 10^3 = \sqrt{\frac{7}{22}} \times 10^3$$

$$\frac{8 \times 8.314 \times T}{\pi \times 16 \times 10^{-3}} = \frac{7}{22} \times 10^6$$

$$T = 240.55K$$

$$T°C = 240.55 - 273 = -32.45°C$$

**24.Sol:**

$$U_{rms} = \sqrt{\frac{3RT}{M}} \text{ and } \frac{(U_{rms})_{H_2}}{(U_{rms})_{N_2}} = \sqrt{\frac{T_{H_2}}{M_{H_2}} \times \frac{M_{N_2}}{T_{N_2}}};$$

$$(U_{rms})_{H_2} = \sqrt{5}\,(U_{rms})_{N_2}$$

$$\therefore \quad \frac{(U_{rms})_{H_2}}{(U_{rms})_{H_2}} = \sqrt{5} = \sqrt{\frac{T_{H_2}}{T_{N_2}} \times \frac{28}{2}}$$

$$\frac{\sqrt{5}}{1} = \sqrt{\frac{T_{H_2}}{T_{N_2}} \times 14}$$

$$5 = \frac{T_{H_2}}{T_{N_2}} \times 14$$

$$T_{N_2} \times 5 = T_{H_2} \times 14$$

$$\therefore \quad T_{N_2} > T_{H_2}$$

**25.Sol:** Conceptual

**26.Sol:** Molecules move very fast in all directions in a straight line by colliding with each other but with different velocity.

**27.Sol:** $U_{rms} = \sqrt{\left(\frac{n_1u_1^2 + n_2u_2^2 + n_3u_3^2 + .....}{n}\right)}$

$$= \sqrt{\left(\frac{4\times(6)^2 + 5\times(2)^2 + 10\times(3)^2}{19}\right)}$$

$$= \sqrt{\left(\frac{4\times36 + 5\times4 + 10\times9}{19}\right)}$$

$$= \sqrt{\left(\frac{254}{19}\right)} = 3.6\ cm\ s^{-1}$$

**28.Sol:** $U_{rms} = \sqrt{\frac{3RT}{M}}$

$$(U_{rms})_{N_2} = \sqrt{\frac{3RT}{28}}$$

$$(U_{rms})_N = \sqrt{\frac{3R(2T)}{14}}$$

$$\frac{u}{(U_{rms})_N} = \frac{1}{2}$$

$$(U_{rms})_N = 2u$$

**29.Sol:** Average velocity $(U_{AV})$ is the of different speeds of all the molecules

$$\therefore\ U_{AV} = \frac{11.2 + 9.0 + 8.3 + 6.5 + 3.7 + 1.8}{6}$$

$$= \frac{40.5}{6} = 6.75\ ms^{-1}$$

Also, $U_{AV} = 0.921$ u; where 'u' is RMS velocity

$\therefore$ RMS velocity $(U_{AV})$

$$= \frac{6.75}{0.9213} = 7.47\ ms^{-1}$$

**30.Sol:** PV = nRT is an ideal gas equation it is allowed when the temperature is high and pressure is low.

**31.Sol:** $\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$

$$\left(P + \frac{2.253}{0.25\times0.25}\right)(0.25 - 0.0428)$$

$$= 0.0821\times300$$

$$(P + 36.048)(0.2072) = 24.63$$

$$P + 36.048 = 118.87$$

$$P = 82.82\ \text{atm.}$$

**32.Sol:** The product PV will have constant value at constant temperature According to Boyle's law.

**33.Sol:** Higher the critical temperature more easily will be the gas liquify. Now since most easily liquifiable gas shows larger deviation, $NH_3$ will show maximum deviation from ideal behaviour.

**34.Sol:** Conceptual

**35.Sol:** Conceptual

**36.Sol:** Conceptual

**37.Sol:** Conceptual

**38.Sol:** Critical temperature, $T_c = \frac{8a}{27Rb}$

Greater the value of $\left(\frac{a}{b}\right)$, more is the critical temperature of gas.

$$Gas\ X, \frac{a}{b} = \frac{6}{0.025} = 240;\ Gas\ Y, \frac{a}{b} = \frac{6}{0.150} = 40;$$

$$GasZ, \frac{a}{b} = \frac{20}{0.1} = 200; GasP, \frac{a}{b} = \frac{0.05}{0.02} = 2.5;$$

$$GasQ, \frac{a}{b} = \frac{30}{0.2} = 150$$

Therefore, gas X will have the highest critical temperature.

**39.Sol:** The real gases show deviation from ideality at low temperature, high pressure and low volume. Thus, at very low temperature, real gases do not show ideal behaviour.

**40.Sol:** Since surface tension depends on the attractive forces between the molecules, and hydrogen bonding a special type of dipole-dipole interactions in (b), (c) and (d) which is stronger than London forces of attraction in hexane.

**41.Sol:** Conceptual

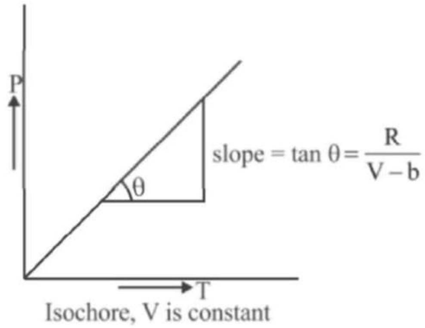




**42.Sol:** The correct order of viscosity of the given liquids is dimethyl ether < methyl alcohol < water < glycerol

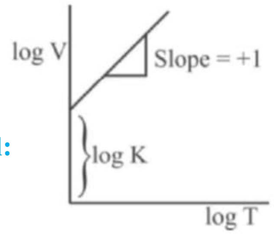
**43.Sol:** P(V - b) = RT

$$P = \frac{R}{V - b}\times T + 0$$




Isochore, V is constant

**44.Sol:**




**45.Sol:** Conceptual

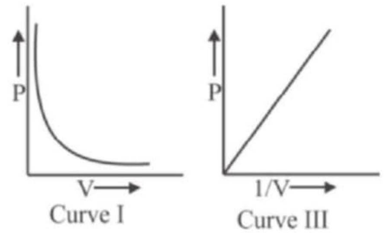
**46.Sol:** For gas A, $a = 0, Z = 1 + \frac{Pb}{RT}$ implies Z varies linearly with pressure.

For gas B, $b = 0, Z = 1 - \frac{a}{VRT}$. Hence Z does not vary linearly with pressure.

Given the intersection data for gas C, it is possible to find the values of 'a' and 'b'. All Van der Wall gases like gas C, gives positive slope at high pressures.

**47.Sol:** Inside the dome showing graph, state is liquid.

**48.Sol:**




Both these graphs represents Boyle's law.

**49.Sol:** At a particular temperature,

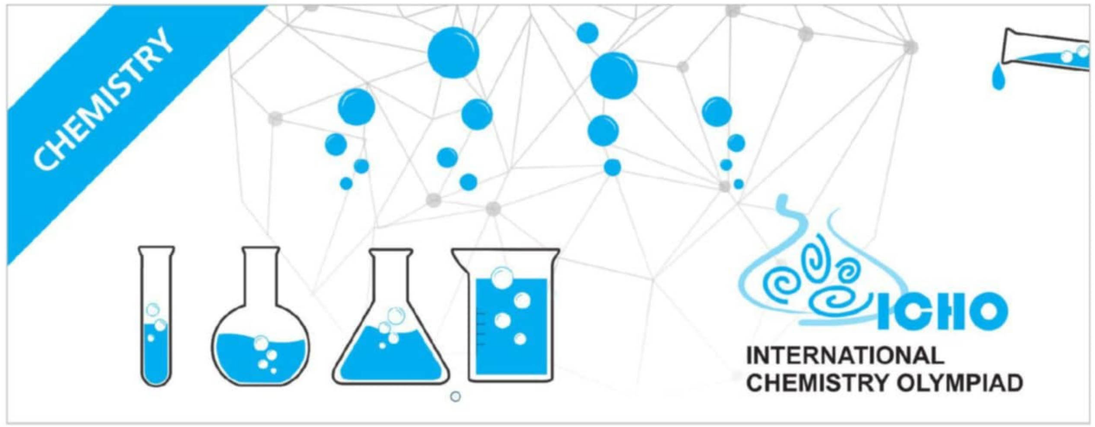
PV = constant

Thus, $P_1V_1 = P_2V_2 = P_3V_3 = P_4V_4$

As, $V_1 > V_2 > V_3 > V_4$,

therefore, $P_1 < P_2 < P_3 < P_4$.

**50.Sol:** The stage 'B' shows the most probable velocity. $U_{MP} = \sqrt{\frac{2RT}{M}}$.




## NSEJS (Stage-1)

### 2009-2010

**1.** Three containers A, B and C of equal volume contains $N_2$, $NO_2$ and $CO_2$ respectively at the same temperature and pressure. The ascending order of their masses is
(a) A, C, B (b) C, A, B
(c) B, C, A (d) C, B, A

**2.** A 3.7 litre 1.0 M NaOH solution is mixed with another 5 litre 0.30 M NaOH solution. The molarity of the resulting solution is
(a) 0.80 M (b) 0.10 M
(c) 0.73 M (d) 0.59 M

**3.** Transition metal ion in amethyst is
(a) $Cr^{3+}$ (b) $Fe^{3+}$ (c) $Mn^{3+}$ (d) $Co^{3+}$

**4.** Among the following the most powerful oxidizing agent is
(a) $O_2$ (b) $KClO_3 + O_2$
(c) $H_2O$ (d) $O_3$

**5.** Formalin is 40% aqueous solution of
(a) formic acid
(b) freon gas
(c) formaldehyde
(d) a mixture of formic acid and formaldehyde in a raito 1: 1

**6.** One mole of oxalic acid is equivalent to :
(a) 0.5 mole of NaOH (b) 1 mole of NaOH
(c) 1.5 mole of NaOH (d) 2 mole of NaOH

**7.** Out of the following the salt/s that has/ have pH value higher than 7.5/is/are :
(a) sodium hydrogen carbonate
(b) sodium sulphate
(c) sodium chloride
(d) sodium carbonate

**8.** Out of the following the metals, the one/s that is/are sonorous is/are :
(a) Zn (b) Na (c) Hg (d) Cu

### 2010-2011

**1.** The order of corrosion of metals, namely aluminium, iron, tin and zinc is
(a) Fe > Sn > Al > Zn
(b) Sn > Fe > Al > Zn
(c) Al > Zn > Fe > Sn
(d) Fe > Zn > Sn > Al

**2.** $\left[O^{2-}\right]$ ion is represented as

(a) $\left[:\ddot{\underset{\cdot\cdot}{O}}:\right]^{2-}$ (b) $\left[:\dot{\underset{\cdot\cdot}{O}}:\right]^{2-}$

(c) $\left[:\dot{\underset{\cdot\cdot}{O}}:\right]^{2-}$ (d) $\left[\cdot\dot{\underset{\cdot\cdot}{O}}\cdot\right]^{2-}$

**3.** The different coloured dyes present in black ink can be separated by
(a) evaporation (b) distillation
(c) centrifugation (d) chromatography





**4.** When 2.8g of nitrogen reacts with 0.6 g of hydrogen, 3.4 g of ammonia gas is produced. If 5.8 g of nitrogen is allowed to react with 0.6g of hydrogen, then the amount of ammonia produced is
(a) 1.7 g (b) 3.4 g (c) 4.7 g (d) 7.4 g

**5.** The valencies of two elements A and B are +2 and +3 respectively. Then, the formula of sulphate of B and chloride of A respectively are

(a) $B_3(SO_4)_2$ and $ACl_2$

(b) $B_2(SO_4)_3$ and $ACl_2$

(c) $BSO_4$ and $A_2Cl$

(d) $B_2SO_4$ and $ACl$

**6.** Copper sulphate is the salt of
(a) a weak acid and a strong base
(b) a weak acid and a weak base
(c) a strong acid and a weak base
(d) a strong acid and a strong base

**7.** A solution having pH = 2 is mixed with excess of solution of washing soda, the pH of mixture is
(a) 4 (b) 5 (c) 6 (d) 8

**8.** Number of molecules present in a given amount of $CO_2$ and $O_2$ is the same at STP. If the weight of $CO_2$ is 5.5g, then the weight of $O_2$ is
(a) 5.5 g (b) 4.4 g (c) 4.0 g (d) 2.0 g

**9.** Isotope used as a fuel in the reactors of nuclear power plants for generating electricity is
(a) As-74 (b) U-235 (c) Co-60 (d) I-131

**10.** The mass of one molecule of phosphorus $\left({}^{31}P\right)$ is

(a) 31 g (b) $2.059\times10^{-22}$ g

(c) $5.147\times10^{-23}$ g (d) 124 g

**11.** The fragrance of burning incense stick spreads all around due to
(a) the sublimation of incense stick
(b) the vaporization of incense stick
(c) the sublimation of fragrance matter into the air
(d) the diffusion of its smoke into the air

**12.** The boiling point of water at STP is
(a) 100 K (b) 373 K
(c) 273 K (d) 373°C

**13.** Unacceptable odour of water can be removed by filtering it through
(a) sand (b) activated charcoal
(c) alum (d) saw dust

**14.** Ammonium chloride is purified by
(a) sublimation
(b) crystallization
(c) fractional crystallization
(d) distillation

**15.** The diameter of a solute particle in a solution is
(a) $\leq10^{-6}$ m (b) $\leq10^{-9}$ m
(c) $\leq10^{6}$ m (d) $\leq10^{9}$ m

**16.** Soaps do not clean clothes in hard water because
(a) hard water contains sodium and potassium ions.
(b) soluble soap is formed in hard water
(c) the precipitate of soap adhereson to the fibre of the cloth as gummy mass
(d) sodium or potassium soap is formed in hard water.

**17.** If the pressure of a given mass of a gas is reduced to half and temperature is doubled simultaneously, the volume will be
(a) the same as before
(b) twice as before
(c) four times as before
(d) one fourth as before

**18.** Oxygen exhibits $(-1)$ oxidation state in
(a) $OF_2$ (b) $H_2O$ (c) $H_2O_2$ (d) HClO

## ANSWER KEY

### 2009-2010

**1.** a **2.** d **3.** d **4.** b **5.** c
**6.** d **7.** a, d **8.** a, d

**2010-2011**

| | | | | |
|---|---|---|---|---|
| **1.** c | **2.** a | **3.** d | **4.** b | **5.** b |
| **6.** c | **7.** d | **8.** c | **9.** b | **10.** b |
| **11.** d | **12.** b | **13.** b | **14.** a | **15.** a |
| **16.** c | **17.** c | **18.** c | | |

## HINTS & SOLUTIONS

**2009-2010**

**1.Sol:** $N_2 = 28g, NO_2 = 46g, CO_2 = 44g$

$\therefore$ Ascending order = A, C, B

**2.Sol:** $M_1V_1 + M_2V_2 = M_3V_3$

$1\times3.7 + 0.3\times5 = M_3\times8.7$

$M_3 = 0.5977\,M$

**3.Sol:** Conceptual

**4.Sol:** $2KClO_3 \rightarrow 2KCl + 3O_2$

**5.Sol:** Conceptual

**6.Sol:** One mole of oxalic acid is neutralised by two moles of NaOH.

**7.Sol:** Sodium hydrogen carbonate and sodium carbonate both are salts of weak acid $(H_2CO_3)$ and strong base $(NaOH)$. Thus their aqueous solutions are alkaline with pH higher than 7.

**8.Sol:** Na, Hg is not sonorous, since Na is very soft and Hg is liquid.

**2010-2011**

**1.Sol:** Conceptual

**2.Sol:** Conceptual

**3.Sol:** Conceptual

**4.Sol:** $N_2 + 3H_2 \rightarrow 2NH_3$

According to equation, 1mole of $N_2$ (28 g) reacts with 3 moles of $H_2$ (6 g) produces 2 moles of $NH_3$ (34 g). So, 2.8 g of $N_2$ reacts with 0.6 g of $H_2$ and produces 3.4 g of $NH_3$. If 5.8 g of $N_2$ is taken, $H_2$ is a limiting reagent. The amount of ammonia produced depends on the amount of $H_2$ reacted i.e., 0.6 g
So, 0.6 g of $H_2$ produces 3.4 g of $NH_3$.

**5.Sol:** Sulphate of B = $B_2(SO_4)_3$

Chloride of A = $ACl_2$

**6.Sol:** Upon hydrolysis $CuSO_4$ gives weak base & strong acid

$$CuSO_4 + 2H_2O \rightarrow \underset{\text{WB}}{Cu(OH)_2} + \underset{\text{SA}}{H_2SO_4}$$

**7.Sol:** Washing soda ( $(Na_2CO_3.10H_2O)$ is salt of SB & WA therefore by the mixing of washing soda pH will be increased.

**8.Sol:** If the no. of moles are same then no. of molecules also same.

$$n_{co_2} = \frac{5.5}{44}$$

$$= 0.125 \text{ mole}$$

1 mole of $O_2 = 32\times0.125 = 4g$

**9.Sol:** Conceptual

**10.Sol:** Mass of $6.023\times10^{23}$ molecules of phosphorus $= 31\times4\,g = 124\,g$

Mass of 1 molecules of phosphorus

$$= \frac{124}{6.023\times10^{23}} = 2.059\times10^{-22}\,g$$

**11.Sol:** Conceptual

**12.Sol:** Conceptual

**13.Sol:** Conceptual

**14.Sol:** Ammonium chloride is a sublimable solid.

**15.Sol:** Conceptual

**16.Sol:** Hard water gives ppt due to the presence of carbonate, sulphate of Ca & Mg ions.

**17.Sol:** $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$V_2 = \frac{2P\times V\times 2T}{P\times T}$$

$V_2 = 4V$

**18.Sol:** $H_2O_2$

Consider oxidation state of 'O' is 'x'

$2 + 2x = 0$

$2x = -2$

$x = -1$

**Hint:** In peroxides $(O_2^{2-})$, oxidation state of oxygen is -1.





# Previous years JEE MAIN Questions

## CHEMICAL BONDING & MOLECULAR STRUCTURE [ONLINE QUESTIONS]

**1.** Which of the following conversions involves change in both shape and hybridisation? **[2018]**

(a) $H_2O \rightarrow H_3O^+$ (b) $BF_3 \rightarrow BF_4^-$

(c) $CH_4 \rightarrow C_2H_6$ (d) $NH_3 \rightarrow NH_4^+$

**2.** The incorrect geometry is represented by: **[2018]**

(a) $NF_3$ - trigonal planar

(b) $BF_3$ -trigonal planar

(c) $AsF_5$ - trigonal bipyramidal

(d) $H_2O$ -bent

**3.** In the molecular orbital diagram for the molecular ion, $N_2^+$, the number of electrons in the $\sigma_{2p}$ molecular orbital is: **[2018]**

(a) 0 (b) 2 (c) 3 (d) 1

**4.** Identify the pair in which the geometry of the species is T-shape and square-pyramidal, respectively: **[2018]**

(a) $ICl_2^-$ and $ICl_5$ (b) $IO_3^-$ and $IO_2F_2^-$

(c) $ClF_3$ and $IO_4^-$ (d) $XeOF_2$ and $XeOF_4$

**5.** $\overset{\text{(I)}}{H-N}\cdots\overset{\text{(II)}}{N}\cdots N$

In hydrogen azide (above) the bond orders of bonds (I) and (II) are: **[2018]**

(I) (II) (I) (II)

(a) <2 >2 (b) >2 >2

(c) >2 <2 (d) <2 <2

**6.** In graphite and diamond, the percentage of p-characters of the hybrid orbitals in hybridization are respectively: **[2018]**

(a) 33 and 25 (b) 67 and 75

(c) 50 and 75 (d) 33 and 75

**7.** The decreasing order of bond angles in $BF_3, NH_3, PF_3$ and $I_3^-$ is: **[2018]**

(a) $I_3^- > BF_3 > NH_3 > PF_3$

(b) $BF_3 > I_3^- > PF_3 > NH_3$

(c) $BF_3 > NH_3 > PF_3 > I_3^-$

(d) $I_3^- > NH_3 > PF_3 > BF_3$

**8.** The group having triangular planar structures is: **[2017]**

(a) $BF_3, NF_3, CO_3^{2-}$ (b) $CO_3^{2-}, NO_3^-, SO_3$

(c) $NH_3, SO_3, CO_3^{2-}$ (d) $NCl_3, BCl_3, SO_3$

**9.** Which of the following is paramagnetic? **[2017]**

(a) $NO^+$ (b) CO (c) $O_2^{2-}$ (d) $B_2$

**10.** The group of molecules having identical shape is: **[2016]**

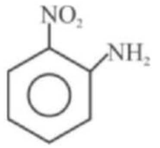
(a) $PCl_5, IF_5, XeO_2F_2$ (b) $BF_3, PCl_3, XeO_3$

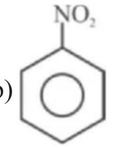
(c) $SF_4, XeF_4, CCl_4$ (d) $ClF_3, XeOF_2, XeF_3^+$

**11.** The bond angle $H-X-H$ is the greatest in the compound: **[2016]**

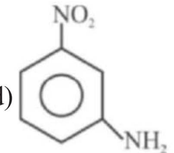
(a) $PH_3$ (b) $CH_4$ (c) $NH_3$ (d) $H_2O$

**12.** Which compound exhibits maximum dipole-moment among the following? **[2016]**

(a) 


(b) 


(c) 


(d) 


**13.** Molecular AB has a bond length of $1.61\mathring{A}$ and a dipole moment of 0 .38 D. The fractional charge on each atom (absolute magnitude) is : $(e_o = 4.802\times10^{-10}\,esu)$ **[2015]**

(a) 0.5 (b) 0.05 (c) 0 (d) 1.0

**14.** Amongst $LiCl, RbCl, BeCl_2$ and $MgCl_2$ the compounds with the greatest and the least character, respectively are: **[2014]**

(a) LiCl and RbCl (b) RbCl and $BeCl_2$

(c) $MgCl_2$ and $BeCl_2$ (d) RbCl and $MgCl_2$

**15.** Which of these statements is not true? **[2014]**

(a) $NO^+$ is not isoelectronic with $O_2$.

(b) B is always covalent in its compounds.

(c) In aqueous solution, the $Tl^+$ ion is much more stable than Tl (III).

(d) $LiAlH_4$ is a versatile reducing agent in organic synthesis.

**16.** The correct order of bond dissociation energy among $N_2, O_2, O_2^-$ is shown which of the following arrangements? **[2014]**

(a) $N_2 > O_2^- > O_2$ (b) $O_2^- > O_2 > N_2$

(c) $N_2 > O_2 > O_2^-$ (d) $O_2 > O_2^- > N_2$

**17.** The number of bonds in $C_2^{2-}$ ion in $CaC_2$ are: **[2014]**

(a) One $\sigma$ bond and one $\pi-$ bond

(b) One $\sigma$ bond and two $\pi-$ bond

(c) Two $\sigma$ bond and two $\pi-$ bond

(d) Two $\sigma$ bond and one $\pi-$ bond

**18.** Which of the following has unpaired electron(s)? **[2014]**

(a) $N_2$ (b) $O_2^-$ (c) $N_2^{2+}$ (d) $O_2^{2-}$

**19.** Which of the following molecules is paramagnetic? **[2014]**

(a) $N_2$ (b) NO (c) CO (d) $O_3$

**20.** Which one of the following molecules is polar? **[2014]**

(a) $XeF_4$ (b) $IF_5$ (c) $SbF_5$ (d) $CF_4$

**21.** Bond distance in HF is $9.17\times10^{-11}m$. Dipole moment of HF is $6.104\times10^{-30}cm$. The percentage ionic character in HF will be: (electronic charge $=1.60\times10^{-19}C$) **[2013]**

(a) 61.0% (b) 38.0%

(c) 35.5% (d) 41.5%

**22.** In which of the following sets, all the given species are isostructural? **[2013]**

(a) $CO_2, NO_2, ClO_2, SiO_2$

(b) $PCl_3, AlCl_3, BCl_3, SbCl_3$

(c) $BF_3, NF_3, PF_3, AlF_3$

(d) $BF_4^-, CCl_4, NH_4^+, PCl_4^+$

**23.** In which of the following ionisation process the bond energy has increased and also the magentic behaviour has changed from paramagnetic to diamagnetic? **[2013]**

(a) $NO \rightarrow NO^+$ (b) $N_2 \rightarrow N_2^+$

(c) $C_2 \rightarrow C_2^+$ (d) $O_2 \rightarrow O_2^+$

**24.** Bond order normally gives idea of stability of a molecular species. All the molecules viz. $H_2, Li_2$ and $B_2$ have the same bond order yet they are not equally stable. Their stability order is: **[2013]**

(a) $H_2 > Li_2 > B_2$ (b) $Li_2 > H_2 > B_2$

(c) $Li_2 > B_2 > H_2$ (d) $B_2 > H_2 > Li_2$

**25.** The internuclear distances in $O-O$ bonds for $O_2^+, O_2, O_2^-$ and $O_2^{2-}$ respectively are : **[2013]**

(a) $1.30\mathring{A}, 1.49\mathring{A}, 1.12\mathring{A}, 1.21\mathring{A}$

(b) $1.49\mathring{A}, 1.21\mathring{A}, 1.49\mathring{A}, 1.30\mathring{A}$

(c) $1.21\mathring{A}, 1.12\mathring{A}, 1.49\mathring{A}, 1.30\mathring{A}$

(d) $1.12\mathring{A}, 1.21\mathring{A}, 1.30\mathring{A}, 1.49\mathring{A}$





## [OFFLINE QUESTIONS]

**1.** Total number of lone pair of electrons in $I_3^-$ ion is: **[2018]**

(a) 6 (b) 9 (c) 12 (d) 3

**2.** According to molecular orbital theory, which of the following will not be a viable molecule? **[2018]**

(a) $He_2^+$ (b) $H_2^-$ (c) $H_2^{2-}$ (d) $He_2^{2+}$

**3.** Which of the following compounds contain(s) no covalent bomds (s) ?

$KCl, PH_3, O_2, B_2H_6, H_2SO_4$ **[2018]**

(a) $KCl, H_2SO_4$ (b) $KCl$

(c) $KCl, B_2H_6$ (d) $KCl, B_2H_6, PH_3$

**4.** Which of the following is paramagnetic? **[2017]**

(a) $NO^+$ (b) $CO$ (c) $O_2^{2-}$ (d) $B_2$

**5.** The species in which the $N$ atom is in a state of $sp$ hybridisation is: **[2016]**

(a) $NO_3^-$ (b) $NO_2$ (c) $NO_2^+$ (d) $NO_2^-$

**6.** The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is: **[2015]**

(a) London force (b) Hydrogen bond

(c) Ion-ion interaction

(d) Ion-dipole interaction

**7.** Which one of the following properties is not shown by NO? **[2014]**

(a) It is diamagnetic in gaseous state

(b) It is neutral oxide

(c) It combines with oxygen to form nitrogen dioxide

(d) It's bond order is 2.5

**8.** In which of the following pairs of molecules/ ions, both the species are not likely to exist? **[2013]**

(a) $H_2^+, He_2^{2-}$ (b) $H_2^-, He_2^{2-}$

(c) $H_2^{2+}, He_2$ (d) $H_2^-, He_2^{2+}$

**9.** Which one of the following molecules is expected to exhibit diamagnetic behaviour? **[2013]**

(a) $CO_2$ (b) $N_2$ (c) $O_2$ (d) $S_2$

**10.** Which of the following is the wrong statement? **[2013]**

(a) ONCl and $ONO^-$ are not isoelectronic.

(b) $O_3$ molecule is bent.

(c) Ozone is violet-black in solid state.

(d) Ozone is diamagnetic gas.

**11.** Stability of the species $Li_2, Li_2^-$ and $Li_2^+$ increases in the order of : **[2013]**

(a) $Li_2 < Li_2^+ < Li_2^-$ (b) $Li_2^- < Li_2^+ < Li_2$

(c) $Li_2 < Li_2^- < Li_2^+$ (d) $Li_2^- < Li_2 < Li_2^+$

**12.** In which of the following sets, all the given species are isostructural? **[2012]**

(a) $CO_2, NO_2, ClO_2, SiO_2$

(b) $PCl_3, AlCl_3, BCl_3, SbCl_3$

(c) $BF_3, NF_3, PF_3, AlF_3$

(d) $BF_4^-, CCl_4, NH_4^+, PCl_4^+$

**13.** Ortho-nitrophenol is less soluble in water than $p$- and $m$-Nitrophenols because: **[2012]**

(a) $o$-nitrophenol is more volatile steam than $p$-isomers

(b) $o$-nitrophenol shows intramolecular H-bonding

(c) $o$-nitrophenol shows intermolecular H-bonding

(d) Melting point of $o$-Nitrophenol is lower than those of $m$- and $p$-isomers.

**14.** The number of bonds between two carbon atoms in calcium carbide is: **[2011]**

(a) One sigma, One pi (b) Two sigma, one pi

(c) Two sigma, two pi (d) One sigma, two pi

**15.** Which one of the following pairs of species have the same bond order? **[2008]**

(a) $CN^-$ and $NO^+$ (b) $CN^-$ and $CN^+$

(c) $O_2^-$ and $CN^-$ (d) $NO^+$ and $CN^+$

**16.** Using MO theory, predict which of the following species has the shortest bond length? **[2008]**

(a) $O_2^+$ (b) $O_2^-$ (c) $O_2^{2-}$ (d) $O_2^{2+}$

**17.** Which of the following hydrogen bond is the strongest? **[2007]**

(a) $O-H---F$ (b) $O-H---H$

(c) $F-H---F$ (d) $O-H---O$

**18.** The charge/size ratio of a cation determines its polarising power. Which one of the following sequences represents the increasing order of thepolarising power of the cationic species, $K^+, Ca^{2+}, Mg^{2+}, Be^{2+}$ ? **[2007]**

(a) $Ca^{2+} < Mg^{2+} < Be^{+} < K^{+}$

(b) $Mg^{2+} < Be^{2+} < K^{+} < Ca^{2+}$

(c) $Be^{2+} < K^{+} < Ca^{2+} < Mg^{2+}$

(d) $K^{+} < Ca^{2+} < Mg^{2+} < Be^{2+}$

**19.** Which of the following species exhibits the diamagnetic behaviour? **[2007]**

(a) NO (b) $O_2^{2-}$ (c) $O_2^{2+}$ (d) $O_2$

## CHEMICAL KINETICS [ONLINE QUESTIONS]

**1.** If 50% of a reaction occurs in 100 seconds and 75% of the reaction occurs in 200 seconds, the order of this reaction is: **[2018]**

(a) 2 (b) 3 (c) Zero (d) 1

**2.** The rate of a reaction A doubles on increasing the temperature from 300 to 310 K. By how much, the temperature of reaction B should be increased from 300 K so that rate doubles if activation energy of the reaction B is twice that of reaction A. **[2017]**

(a) 4.92 K (b) 9.84 K

(c) 19.67 K (d) 2.45 K

**3.** The reaction of ozone with oxygen atoms in the presence of chlorine atoms can occur by a two step process shown below: **[2016]**

$O_3(g) + Cl^{\bullet}(g) \rightarrow O_2(g) + ClO^{\bullet}(g)$ ...(i)

$k_i = 5.2\times10^{9}\,L mol^{-1}s^{-1}$

$ClO^{\bullet}(g) + O^{\bullet}(g) \rightarrow O_2(g) + Cl^{\bullet}(g)$ ...(ii)

$k_{ii} = 2.6\times10^{10}\,L mol^{-1}s^{-1}$

The closest rate constant for the overall reaction $O_3(g) + O^{\bullet}(g) \rightarrow 2O_2(g)$ is:

(a) $1.4\times10^{20}\,L mol^{-1}s^{-1}$ (b) $5.2\times10^{9}\,L mol^{-1}s^{-1}$

(c) $3.1\times10^{10}\,L mol^{-1}s^{-1}$ (d) $2.6\times10^{10}\,L mol^{-1}s^{-1}$

**4.** The rate law for the reaction below is given by the expression r = k [A][B]

$A + B \rightarrow$ Product

If the concentration of B is increased from 0.1 to 0.3 mole, keeping the value of A at 0.1 mole, the rate constant will be : **[2016]**

(a) 9 k (b) 3 k (c) k/3 (d) k

**5.** $A + 2B \rightarrow C$, the rate equation for this reaction is given as Rate = k[A][B]. If the concentration of A is kept the same but that of B is doubled what will happen to the rate itself? **[2015]**

(a) Doubled (b) Quadrupled

(c) The same (d) Halved

**6.** For the reaction $3A + 2B \rightarrow C + D$ the differential rate law can be written as: **[2014]**

(a) $-\frac{1}{3}\frac{d[A]}{dt} = \frac{d[C]}{dt} = k[A]^n[B]^m$

(b) $+\frac{1}{3}\frac{d[A]}{dt} = -\frac{d[C]}{dt} = k[A]^n[B]^m$

(c) $\frac{1}{3}\frac{d[A]}{dt} = \frac{d[C]}{dt} = k[A]^n[B]^m$

(d) $-\frac{d[A]}{dt} = \frac{d[C]}{dt} = k[A]^n[B]^m$

**7.** In the reaction of formation of sulphur trioxide by contact process $2SO_2 + O_2 \rightleftharpoons 2SO_3$ the rate reaction was measured as

$\frac{d[O_2]}{dt} = -2.5\times10^{-4}\,mol\,L^{-1}s^{-1}$. The rate of reaction in terms of $[SO_2]$ in $mol\,L^{-1}s^{-1}$ will be **[2014]**

(a) $-2.25\times10^{-4}$ (b) $-5.00\times10^{-4}$

(c) $-3.75\times10^{-4}$ (d) $-2.50\times10^{-4}$

**8.** For reaction, $2N_2O_5 \rightarrow 4NO_2$, the rate equation can be expressed in two ways

$-\frac{d[N_2O_5]}{dt} = k[N_2O_5]$ and

$+\frac{d[NO_2]}{dt} = k'[N_2O_5]$ k and k' are related **[2014]**





(a) $k = 4k'$ (b) $k = 2k'$ (c) $2k = k'$ (d) $k = k'$

**9.** The half life period of a first order reaction is 15 minutes. The amount of substance left after one hour will be : **[2014]**

(a) $\frac{1}{4}$ of the original amount

(b) $\frac{1}{16}$ of the original amount

(c) $\frac{1}{32}$ of the original amount

(d) $\frac{1}{8}$ of the original amount

**10.** The rate constant (k) for a particular reaction is $1.3\times10^{-4}\,M^{-1}s^{-1}$ at $100^{o}C$, and $1.3\times10^{-3}\,M^{-1}s^{-1}$ at $150^{o}C$. What is the energy of activation $(E_a)$ (in kJ) for the reaction? (R = molar gas constant $= 8.314\,JK^{-1}mol^{-1}$) **[2014]**

(a) 132 (b) 60 (c) 99 (d) 16

**11.** A radioactive isotope having a half-life period of 3 days was received after 12 days. If 3g of the isotope is left in the container, what would be the initial mass of the isotope ? **[2013]**

(a) 12 g (b) 36g (c) 48 g (d) 24 g

## ANSWER KEY

### CHEMICAL BONDING & MOLECULAR STRUCTURE [ONLINE QUESTIONS]

| | | | | |
|---|---|---|---|---|
| **1.** b | **2.** a | **3.** d | **4.** d | **5.** a |
| **6.** b | **7.** a | **8.** b | **9.** d | **10.** d |
| **11.** b | **12.** c | **13.** b | **14.** b | **15.** a |
| **16.** c | **17.** b | **18.** b | **19.** b | **20.** b |
| **21.** d | **22.** d | **23.** a | **24.** a | **25.** d |

### [OFFLINE QUESTIONS]

| | | | | |
|---|---|---|---|---|
| **1.** b | **2.** c | **3.** b | **4.** b | **5.** c |
| **6.** b | **7.** a | **8.** c | **9.** (a, b) | **10.** All |
| **11.** b | **12.** d | **13.** b | **14.** d | **15.** a |
| **16.** d | **17.** c | **18.** d | **19.** b | |

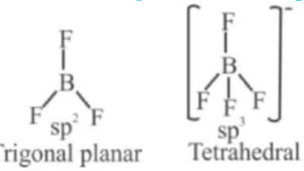
### CHEMICAL KINETICS [ONLINE QUESTIONS]

| | | | | |
|---|---|---|---|---|
| **1.** d | **2.** a | **3.** b | **4.** d | **5.** a |
| **6.** a | **7.** b | **8.** c | **9.** b | **10.** b |
| **11.** c | | | | |

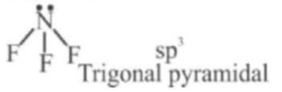
## HINTS & SOLUTIONS

### CHEMICAL BONDING & MOLECULAR STRUCTURE [ONLINE QUESTIONS]

**1.Sol:**



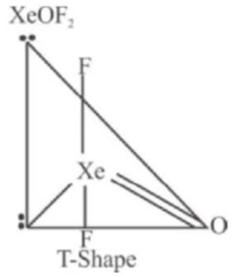

**2.Sol:**

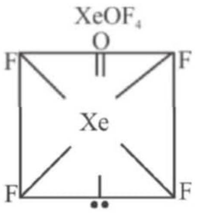


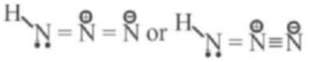

**3.Sol:** $N_2^{+} \rightarrow \sigma_{1s^2}, \sigma^{*}_{1s^2}, \sigma_{2s^2}, \sigma^{*}_{2s^2}, \left[\pi^{2}_{2p_x} = \pi^{2}_{2p_y}\right] \sigma^{1}_{2p_z}$

Number of electron in $\sigma_{2sp_z}$ is 1

**4.Sol:**



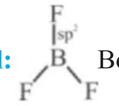




**5.Sol:** 

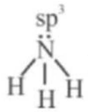
**6.Sol:**

| Graphite | Diamond |
|---|---|
| $sp^2$ hybridisation | $sp^3$ hybridisation |
| $\%P = \frac{2}{3}\times 100 = 67\%$ | $\%P = \frac{3}{4}\times 100 = 75\%$ |

**7. Sol:**

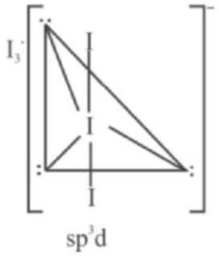



Bond angle $= 120^0$




Bond angle $= 107^0$


When central atom size ↑ Bond angle ↓




Bond angle $180^0$

Bond Angle $PF_3 < NH_3 < BF_3 < I_3^-$

**8.Sol:** Group Hybridisation Shape

(a) $BF_3$ $sp^2$ Triangular Planar (TP)

$NF_3$ $sp^3$ Tetrahedral(T)

$CO_3^{2-}$ $sp^2$ T.P.

(b)

| | | |
|---|---|---|
| $CO_3^{2-}$ | $sp^2$ | $T.P.$ |
| $NO_3^-$ | $sp^2$ | $T.P.$ |
| $SO_3$ | $sp^2$ | $T.P.$ |

(c)

| | | |
|---|---|---|
| $NH_3$ | $sp^2$ | $T$ |
| $SO_3$ | $sp^2$ | $T.P.$ |
| $CO_3^{2-}$ | $sp^2$ | $T.P.$ |

(d)

| | | |
|---|---|---|
| $NCl_3$ | $sp^2$ | $T$ |
| $BCl_3$ | $sp^2$ | $T.P.$ |
| $SO_3$ | $sp^2$ | $T.P.$ |

**9. Sol:** Total electron

| | |
|---|---|
| $NO^+$ | 14 |
| CO | 14 |
| $O_2^{2-}$ | 18 |
| $B_2$ | 10 |

$NO^+ \Rightarrow KK.\sigma(2s)^2\sigma^*(2s)^2.(\pi 2p_x)^2$
$= (\pi 2p_y)^2.(\sigma 2p_z)^2$ diamagnetic

$CO \Rightarrow KK.\sigma(2s)^2\sigma^*(2s)^2.(\pi 2p_x)^2$
$= (\pi 2p_y)^2.(\sigma 2p_z)^2$ diamagnetic

$O_2^{2-} \Rightarrow KK.\sigma(2s)^2\sigma^*(2s)^2.(\pi 2p_z)^2(\pi 2p_x)^2$
$= (\pi 2p_y)^2.(\sigma 2p_z)^2 = \pi^*(2p_y)^2$ diamagnetic

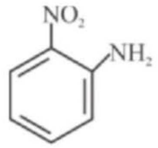
$B_2 \Rightarrow KK.\sigma(2s)^2\sigma^*(2s)^2.(\pi 2p_z)^1 = \pi(2p_y)^1$
paramagnetic

**10.Sol:** $ClF_3$, $XeOF_2$ and $XeF_3^+$

All molecules have $sp^3d$ hybridisation and 2 lone pairs. Hence all have identical (T-shape).

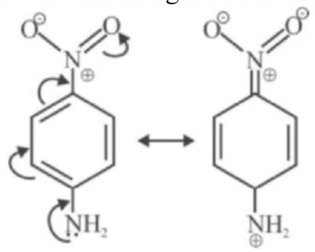
**11.Sol:** More the number of lone pair on central atom, the greater is the concentration caused in the angle between bond pairs. In $CH_4$ there is no lone pair of electrons hence bond angle is the greatest.

**12.Sol:**




Dipole moment = (Distance between opposite charges) × (charge, q) $\mu = q \times d$

So, greater the distance between the opposite charges higher the dipole. Due to the resonance the greater charge separation occurs between charges due to linearity.








**13. Sol:** $1e = 1.602\times 10^{-19} C$

$1esu = 3.33\times 10^{-10} C$

$\frac{1e}{1esu} = \frac{1.602\times 10^{-19} C}{3.33\times 10^{-10} C}$

$1e = 4.802\times 10^{-10} esu$

Dipole moment = q × distance

$\Rightarrow 1D \approx 10^{-18} esu\ cm$

$0.38\times 10^{-18} esu\ cm = q\times(1.61\times 10^{-8} cm)$

$q = 2.36\times 10^{-11} esu$

$q = \frac{2.36\times 10^{-11} esu}{4.802\times 10^{-10} esu}$

$q = 0.049$

$q \approx 0.05$ fractional charge

**14. Sol:** According to Fajan's rules smaller, highly charged cation has the greatest covalent character while large cation with smaller charge has the greatest ionic character.

**15.Sol:** $NO^+ = 7+8-1 = 14e^-$.

$O_2 = 16e^-$

i.e., not isoelectric

**16.Sol:** The bond order of $N_2, O_2$ and $O_2^-$ are respectively 3, 2 and 1.5

Since higher bond order implies higher bond dissociation energy hence the correct order will be $N_2 > O_2 > O_2^-$

**17.Sol:** The structure of $CaC_2$ is $Ca^{2+}[:C \equiv C:]^2$

i.e., one $\pi$ and two $\sigma$ bonds

**18.Sol:** $O_2^{2-}(17) = KK(\sigma 2s)^2(\sigma^* 2s^2)(\sigma 2p_x)^2$

$(\pi 2p_y)^2(\pi 2p_z)(\pi^* 2p_y)^2(\pi^* 2p_z)^1$

**19.Sol:** The molecular orbital configuration of the molecules given is

Total no. of electrons in NO = 7(N) + 8(O) = 15

Hence E.C. of

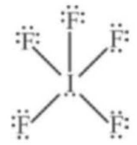
$NO = KK[\sigma(2s)]^2[\sigma^*(2s)]^2[\sigma(2p_z]^2$

$[\pi(2p_x)]^2[\pi(2p_y)]^2[\pi^*(2p_x)]^1$

Due to presence of one unpaired electron NO is paramagnetic.

Except NO al are diamagnetic due to absence of unpaired electrons.

**20.Sol:** The geometry of $IF_5$ is square Pyramide with an unsymmetric charge distribution therefore this molecule is polar.




**21.Sol:** Given $e = 1.60\times 10^{-19} C$

$d = 9.17\times 10^{-11} m$

From $\mu = e\times d$

$\mu = 1.60\times 10^{-19}\times 9.17\times 10^{-11} = 14.672\times 10^{-30}$

% ionic character

$= \frac{Observed\ dipole\ moment}{Dipole\ moment\ for\ 100\%\ ionic\ bond}$

$= \frac{6.104\times 10^{-30}}{14.672\times 10^{-30}}\times 100 = 41.5\%$

**22.Sol:** All have tetrahedral structure.

**23.Sol:** For NO

Total no. of electrons = 15

B.O = 2.5

Mag. Behaviour = Paramagnetic

For $NO^+$

Total no. of electrons = 14

B.O = 3

Mag. Behaviour = Diamagnetic

**24.Sol:** None of the given option is correct.

The molecular orbital configuration of the given molecules is $H_2 = \sigma 1s^2$ (no electron anti-bonding) $Li_2 = \sigma 1s^2\ \sigma^* 1s^2\sigma 2s^2$ (two anti-bonding electrons)

$B_2 = \sigma 1s^2\ \sigma^* 1s^2\sigma 2s^2\sigma^* 2s^2\{\pi 2p_y^1 = \pi 2p_z^1\}$

(4 anti-bonding electrons)

Though the bond order of all the species are same (B.O = 1) but stability is different. This is due to difference in the presence of no. of anti-bonding electron.

Higher the no. of anti-bonding electron lower is the stabiltiy hence the correct order is

$H_2 > Li_2 > B_2$

**25.Sol:** The bond length follows the order

$$O_2^+ < O_2 < O_2^- < O_2^{2-}$$

According to this the possible values are

$$1.12\mathring{A}, 1.21\mathring{A}, 1.30\mathring{A}, 1.49\mathring{A}$$

## [OFFLINE QUESTIONS]

**1. Sol:**

Total number of lone pairs in $I_3^-$ is 9

**2.Sol:** The electronic configuration of $H_2^{2-}$ is

$$\Rightarrow (\sigma 1s^2), (\sigma^* 1s)^2$$

Bond order of $H_2^{2-} = \frac{N_b - N_a}{2} = \frac{2-2}{2} = 0$

Hence $H_2^{2-}$ as exist, due to zero order is zero.

**3.Sol:** $PH_3$, $O_2$, $B_2H_6$, $H_2SO_4$ } All are covalent compounds

$KCl$ is ionic compound.

**4.Sol:** $NO \rightarrow$ one unpaired electron is present in $\pi^*$ molecular orbit hence paramagnetic.

**5.Sol:** Hybridisation $(H) = \frac{1}{2}$ [no.of valence electron of central atom + no.of Monovalent atoms attached to it + (- ve charge if any ) - ( + ve charge if any)]

$NO_2^+ = \frac{1}{2}[5+0+0-1] = 2$ i.e., $sp$ hybridisation

$NO_2^- = \frac{1}{2}[5+0+1-0] = 3$ i.e., $sp^2$ hybridisation

$NO_3^- = \frac{1}{2}[5+0+1-0] = 3$ i.e., $sp^2$ hybridisation

The lewis structure of $NO_2$ shows a bent molecular geometry with trigonal planar electron pair geometry hence the hybridisation will be $sp^2$

**6.Sol:** Hydrogen bond is a type of strong electrostatic dipole interaction and dependent on the inverse cube of distance bewteen the molecular ion-dipole interaction and dependent on the inverse cube of distance between the molecular ion-dipole interaction $\propto \frac{1}{r^3}$.

**7.Sol:** Nitric oxide is paramagnetic. In the gaseous state because of the presence of one unpaired electron in its outermost shell.

The electronic configuration of $NO$ is

$$\sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2 \sigma_{2s}^{*2} \sigma_{2p_z}^2 \pi_{2p_x}^2 = \pi_{2p_y}^2 \pi_{2px}^{*1}$$

**8.Sol:** $H_2^{2+} = \sigma 1s^0 \sigma^* 1s^0$

Bond order for $H_2^{2+} = \frac{1}{2}(0-0) = 0$

$He_2 = \sigma 1s^2 \sigma^* 1s^2$

Bond order for $He_2 = \frac{1}{2}(2-2) = 0$

so both $He_2^{2+}$ and $He_2$ does not exist.

**9.Sol:** The molecular orbital structures of $C_2$ and $N_2$ are

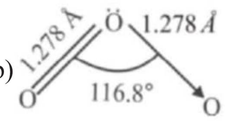
$N_2 = \sigma 1s^2 \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2 \sigma 2p_x^2 \pi 2p_y^2 \pi 2p_z^2$

$C_2 = \sigma 1s^2 \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2 \pi 2py^2 \pi 2P_z^2$

Both $N_2$ and $C_2$ have paired electrons, hence they are diamagnetic.

**10.Sol:** All options are correct,

(a) $ONCl = 8+7+17 = 32e^-$, $ONO^- = 8+7+8+1 = 24e^-$ } not isoelectronic

(b) 

The central atom is $sp^2$ hybridised with one lone pair.





(c) It is a pale blue gas. At $-249.7°$, it forms violet black crystals.

(d) It is diamagnetic in nature due to absence of unpaired electrons.

**11.Sol:** $Li_2 = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2$

$\therefore$ Bond order $= \frac{1}{2}(4-2) = 1$

$Li_2^+ = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^1$

$B.O.\ \ \frac{1}{2}(3-2)\ 0.5$

$Li_2^- = \sigma 1s^2 \sigma^* 1s^2\ 2s^2 \sigma^* 2s^2\ 2s^1$

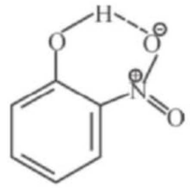
$B.O. = \frac{1}{2}(4-3)\ \ 0.5$

The bond order of $Li_2^+$ and $Li_2^-$ is same but $Li_2^+$ is more stable than $Li_2^-$ because $Li_2^+$ is smaller in size and has 2 electrons in antibonding orbitals whereas $Li_2^-$ has 3 electrons in antibonding orbitals. Hence $Li_2^+$ is more stable than $Li_2^-$.

**12.Sol:** All have tetrahedral structure.

**13. Sol:** Compounds involved in chelation become non-polar.

Consequently such compounds are soluble in non-polar solvents like ether, benzene etc. and are only sparingly soluble in water & less soluble in non-polar solvents.


intramolecular H-bonding

**14.Sol:** Calcium carbide exists as $Ca^{2+}$ and $C_2^{2-}$.

According to the molecular orbital model, $C_2^{2-}$ should have molecular orbital configuration:

$\sigma 1s^2\ \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2$

$\{\pi 2p_y^2 = \pi 2p_z^2\}\ \sigma p_x^2$

Thus M.O. configuration suggests that it contains one $\sigma$ & $2\pi$ bonds.

**15.Sol:** For any species to have same bond order we can expect them to have same number of electrons. Calculating the number of electrons in various species.

$O_2^-(8+8+1=17); CN^-(6+7+1=14)$

$NO^+(7+8-1=14); CN^+(6+7-1=12)$

We find $CN^-$ and $NO^+$ both have 14 electrons so they have same bond order.

**16.Sol:** Bond order

$$= \frac{No\ of\ bonding\ electrons - No.of\ anti\text{-}bonding\ electrons}{2}$$

Bond order in $O_2^+ = \frac{10-5}{2} = 2.5$

Bond order in $O_2^- = \frac{10-7}{2} = 1.5$

Bond order in $O_2^{2-} = \frac{10-8}{2} = 1$

Bond order in $O_2^{2+} = \frac{10-4}{2} = 3$

Since Bond order $\propto \frac{1}{Bond\ length}$

$\therefore$ Bond length is shortest in $O_2^{2+}$.

**17.Sol:** Greater the difference between electro-negativity of bonded atoms, stronger will be bond. Since F is most electronegative hence $F-H---F$ is the strongest bond.

**18.Sol:** Smaller the size and higher the charge more will be polarising power of cation. Since the order of the size of cation is

$K^+ < Ca^{++} < Mg^{++} > Be^{++}$. So the correct order of polarising power is

$K^+ < Ca^{2+} < Mg^{2+} > Be^{2+}$

**19.Sol:** Diamagnetic species have no unpaired electrons

$O_2^{2-} \Rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_x^2,$

$\{\pi 2p_y{}^2 = \pi 2p_z{}^2, \{\pi^* 2p_y^2 = \pi^* 2p_z^2$

Whereas paramagnetic species has one or more unpaired electrons as in

$O_2 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_x^2, \{\pi 2p_y^2 = \pi 2p_z^2,$

$\{\pi^* 2p_y^1 = \pi^* 2p_z^1 - 2$ unpaired electrons

$O_2^+ \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma^* 2s^2, \sigma^* 2p_x^2,$

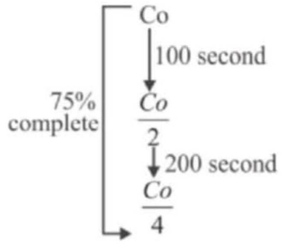
$\{\pi 2p_y^2 = \pi 2p_z^2 \{\pi^* 2p_z^1 - \pi^* 2p_z^0 - 1$ unpaired electron

$NO \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_x^2, \pi 2p_z^2,$

$\{\pi^* 2p_y^1 = \pi^* 2p_z^0 - 1$ unpaired electron

## CHEMICAL KINETICS [ONLINE QUESTIONS]

**1. Sol:**




First order reaction as half life is constant.

**2.Sol:** $\ln(k_2/k_1) = (E_a/R)\,[1/T_1 - 1/T_2]$

$$\ln(2) = \frac{E_a}{R}\left\{\frac{1}{300} - \frac{1}{310}\right\} \quad \ldots(i)$$

$$\ln(2) = 2\frac{E_a}{R}\left\{\frac{1}{300} - \frac{1}{T}\right\} \quad \ldots(ii)$$

$$\frac{2E_a}{R}\left\{\frac{1}{300} - \frac{1}{T}\right\} = \frac{E_a}{R}\left\{\frac{1}{300} - \frac{1}{310}\right\}$$

$$\frac{1}{300} + \frac{1}{310} = \frac{2}{T} \Rightarrow T = \frac{300\times 310}{610}\times 2$$

T = 304.92

**3.Sol:** The rate constant of overall reaction depends on slowest step. Hence equation (i) is slowest step. Option (b) is correct.

**4.Sol:** Conceptual

**5.Sol:** Rate = k [A][B] = r

$r' = k[A][2B]$

$$\frac{r}{r'} = \frac{k[A][B]}{k[A][2B]} = \frac{k[A][B]}{2k[A][B]}$$

$\Rightarrow 2r = r'$ i.e., rate become double.

**6.Sol:** Rate $= -\frac{1}{3}\frac{d[A]}{dt} = -\frac{1}{2}\frac{d[B]}{dt} = \frac{d[C]}{dt} = \frac{d[D]}{dt}$

Rate $= k[A]^n\,[B]^m$

$$-\frac{1}{3}\frac{d[A]}{dt} = -\frac{1}{2}\frac{d[B]}{dt} = \frac{d[C]}{dt} = \frac{d[D]}{dt}$$

$= k[A]^n\,[B]^m$

so $$-\frac{1}{3}\frac{d[A]}{dt} = \frac{d[C]}{dt} = k[A]^n\,[B]^m$$

**7. Sol:** $$-\frac{1}{2}\frac{d}{dt}[SO_2] = -\frac{d}{dt}[O_2]$$

$$\Rightarrow \frac{d}{dt}[SO_2] = -2\times 2.5\times 10^{-4} = -5\times 10^{-4}$$

**8. Sol:** $2N_2O_5 \rightarrow 4NO_2 + O_2$

$$-\frac{d}{dt}[N_2O_5] = k[N_2O_5]$$

Now $$\Rightarrow -\frac{1}{2}\frac{d}{dt}[N_2O_5] = \frac{1}{4}\times k'[N_2O_5]$$

$\Rightarrow 2k = k'$

**9.Sol:** Since $t_{1/2} = 15$ min

$\therefore$ No. of half lives $= \frac{6}{15} = 4$

$\therefore$ Amount of substance left after one hour

$$= \frac{A_0}{(2)^n} = \frac{A_0}{(2)^4} = \frac{A_0}{16}$$

**10.Sol:** $$\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\Rightarrow \log\frac{1.3\times 10^{-3}}{1.3\times 10^{-4}} = \frac{E_a}{2.303R}\left[\frac{1}{373} - \frac{1}{423}\right]$$

$$\Rightarrow 1 = \frac{E_a}{2.303R}\left[\frac{50}{373\times 423}\right]$$

$$\Rightarrow E_a = \frac{2.303\times 8.314\times 373\times 423}{1000\times 50}$$

$= 60.42$ kJ

**11.Sol:** Given $t_{1/2} = 3$

Total time $T = 12$

No. of half lives $(n) = \frac{12}{3} = 4$

$$\left(\frac{1}{2}\right)^n = \frac{N}{N_o}$$

$$\therefore \left(\frac{1}{2}\right)^4 = \frac{3}{N}$$

$$\frac{3}{N} = \frac{1}{16} \quad \therefore \quad N = 48g$$





# NTSE

### 2018-2019

**1.** Which of the following sets of phenomena would increase on raising the temperature? *[Andhra Pradesh]*
(i) Evaporation of liquid
(ii) Sublimation of solid
(iii) Solubility of solute in water
(iv) Solubility of gases in water
(a) (i) and (ii) (b) (i),(ii) and (iii)
(c) (i) and (ii) (d) (i),(ii),(iii) and (iv)

**2.** The fragrance of flowers is due to the presence of some steam volatile organic compounds called essential oils. These are generally insoluble in water at room temperature but are miscible with water vapour in vapour phase. A suitable method for the extraction of these oils from the flower is *[Goa]*
(a) Distillation
(b) Crystallisation
(c) Distillation under reduced pressure
(d) Steam distillation.

**3.** The melting point of ice is ------- *[Gujarat]*
(a) 273.15 K (b) 173.15 K
(c) 373.5 K (d) 100 K

**4.** ----- is not an example of aerosol. *[Gujarat]*
(a) Fog (b) Clouds
(c) Mist (d) Shaving cream

**5.** An example(s) of endothermic process (es) is (are) *[Karnataka]*
(i) Dilution of sulphuric acid
(ii) Sublimation of dry ice
(iii) Condensation of water vapours
(iv) Evaporation of water
(a) (i) and (ii) (b) (ii) only
(c) (iii) Only (d) (ii) and (iv)

**6.** Which of the following will show Tyndall effect? *[Madhya pradesh]*
(a) Solution of salt
(b) Milk
(c) Solution of copper sulphate
(d) None of the above

**7.** Solution is
(a) Homogeneous mixture
(b) Heterogeneous mixture
(c) Colloidal
(d) All of these.

**8.** The substance showing sublimation property among the following is *[Rajasthan]*
(a) Common salt (b) Copper sulphate
(c) Potassim nitrate (d) Camphor.

**9.** The best method to detect and identify the drugs present in the blood of criminals in forensic science is *[Tamil Nadu]*
(a) Sublimation (b) Evaporation
(c) Chromatography (d) Filtration.

**10.** The physical combination of two substance is called *[Telangana]*
(a) Mixture (b) Compound
(c) Colloid (d) Suspension.

**11.** If 110 g of a salt is present in 550 g of solution then the concentration of solution will be *[Uttarakhand]*
(a) 50% (b) 40% (c) 20% (d) 10%

### 2017-2018

**12.** Which one of the following combinations is false? *[Andhra Pradesh]*

| Solution | Particle size |
|---|---|
| (a) Colloidal solution | $10^{-5}$ to $10^{-7}$ cm |
| (b) True solution | $10^{-7}$ to $10^{-8}$ cm |
| (c) Suspension | $10^{-9}$ to $10^{-12}$ cm |

(d) All are correct combinations.

**13.** The purity of a substance can be gauged by the following, except *[Andhra Pradesh]*

(a) Its melting point
(b) Its boiling point
(c) Chromatography
(d) Physical appearance.

**14.** Which of the following statements is correct in context to Tyndall effect? *[Bihar]*
(a) Scattering and polarizing of light by small suspended particles is called Tyndall effect.
(b) Tyndall effect of colloidal particles is due to dispersion of light.
(c) Tyndall effect is due to refraction of light.
(d) Tyndall effect is due to zig-zag motion of suspended particles.

**15.** Face cream is an example of -------. *[Chandigarh]*
(a) Aerosol (b) Emulsion
(c) Foam (d) Gel

**16.** The physical state of water at 298 K temperature is *[Chattisgarh]*
(a) Gaseous (b) Solid
(c) liquid (d) Plasma.

**17.** In which state of a substance, it has the shape? *[Gujarat]*
(a) Liquid (b) Liquid and gas
(b) Gas (d) Solid

**18.** Choose the correct option about cheese. *[Haryana]*
(a) Cheese is an example of emulsion in which dispersed phase is liquid and dispersing medium is solid
(b) Cheese is an example of gel in which dispersed phase is solid and dispersing medium is liquid.
(c) Cheese is an example of emulsion in which dispersed phase is solid and dispersing medium is liquid.
(d) Cheese is an example of gel in which dispersed phase is liquid and dispersing medium is solid.

**19. Assertion** (A): $CO_2$ is a gas but $SiO_2$ is a solid at room temperature.
**Reason** (R): $CO_2$ contains $C=O$ bonds but $SiO_2$ does not contain $Si=O$ bonds. *[Haryana]*
(a) Both A and R are true and R is a correct explanation of A.
(b) Both A and R are true and R is not correct explanation of A.
(c) A is true, R is false.
(d) A is false, R is true.

**20.** Which of the following is correctly matched? *[Jharkhand]*

| | |
|---|---|
| (a) Gel | Colloid- size cluster of molecules |
| (b) Coagulation | Reversible aggregation of colloidal particles |
| (c) Micellees | A semi rigid mass of lyophilic sol having a network |
| (d) Flocculation | Irreversible aggregation of colloidal particle |

**21.** During depression of freezing point in a solution, which of the following are in equilibrium? *[Jharkhand]*
(a) Liquid solvent and solid solvent
(b) Liquid solvent and solid solute
(c) Liquid solute and solid solute
(d) Liquid solute and solid solvent

**22.** High melting point of a compound indicates *[Panjab]*
(a) Strong intermolecular forces
(b) Kinetic energy of molecules is more
(c) Speed of molecules is more
(d) Compound can diffuse easily.

**23.** The method for separation of mixture of common salt and ammonium chloride is *[Rajasthan]*
(a) Fractional distillation
(b) Sublimation
(c) Chromatography
(d) Crystallization.

**24.** Which one of the following is available in three states? *[Telangana]*
(a) Petrol (b) Water
(c) Milk (d) Kerosene

**25.** If 100 g of salt solution contains 20 g of salt dissolved in it, the percentage of mass of the solution is *[Telangana]*
(a) 10% (b) 20% (c) 15% (d) 25%

**26.** Miscible liquids can be separated by *[Telangana]*
(a) Distillation process
(b) Fractional distillation
(c) Chromatography





(d) Separating funnel.

**27.** Mud is an example of *[Uttarakhand]*
(a) Aerosal (b) Foam
(c) Sol (d) Gel

**28.** What type of colloidal system is fog? *[Uttar Pradesh]*
(a) Gas in liquid (b) Liquid in gas
(c) Liquid in liquid (d) Solid in gas

**29.** 10 mL of an aqueous solution contains 222 mg dissolved $CaCl_2$ (molecular weight =111). What will be the concentration of chloride ion in the resulting solution when it is diluted to 100 mL? *[West Bengal]*
(a) 0.02 moles/L (b) 0.01 moles/L
(c) 0.04 moles/L (d) 2.0 moles/L

## 2016-2017

**30.** The path of light gets illuminated when passed through the *[Andhra Pradesh]*
(a) Blood solution $_{(aq)}$
(b) brine solution $_{(aq)}$
(c) Copper sulphate solution $_{(aq)}$
(d) Acetic acid solution $_{(aq)}$

**31.** On arranging water, sugar and oxygen in increasing order of attraction between their particles, Which of the following will be the correct arrangement? *[Chattisgarh]*
(a) Water, Oxygen, Sugar
(b) Oxygen, Sugar, Water
(c) Sugar, Oxygen, Water
(d) Oxygen, Water, Sugar

**32.** Which of the following will show Tyndall effect? *[Delhi]*
(a) Solution of common salt in water
(b) Starch Soluition
(c) Solution of sugar in water
(d) Vinegar

**33.** Out of the following, Which is the incorrect statement? *[Delhi]*
(a) Adsorption is always an exothermic process.
(b) The soap solution is not a colloidal solution below its CMC.
(c) 'Argyrol' used in eye - lotion is a colloidal solution.
(d) Gold number is the number of moles of gold formed in anode mud during copper refining.

**34.** $25°C = ---- K$ *[Gujarat]*
(a) 273 (b) 248 (c) 298 (d) -298

**35.** Which of the following shows the Tyndall effect? *[Gujarat]*
(a) Solution of common salt
(b) Milk
(c) Lemon juice
(d) Solution of copper sulphate

**36.** To prepare 100 mL 2M NaOH solution------ g of NaOH will be required. *[Gujarat]*
(a) 40 g (b) 8 g (c) 16 g (d) 24 g

**37.** 10 g of hydrogen is burnt in the presence of excess oxygen. The amount of water formed is *[Jharkhand]*
(a) 90 g (b) 45 g (c) 10 g (d) 18 g.

**38.** The law that explains the death of deep sea fish *[ Karnataka]*
(a) Charle's law
(b) Graham's law of diffusion
(c) Both (a) and (b)
(d) None of the above

**39.** Steps of an activity for boiling under reduced pressure are jumbled below. Correctly arranged option is: *[ Karnataka]*
(i) Coil the flask over running water from a tap carefully.
(ii) Water inside the flask starts boiling again .
(iii)Take a cup of water in a conical flask.
(iv)Gases in the flask are removed from the steam produced.
(v) Boil the water without closing its mouth for 3 minutes.
(vi) Close the flask with a rubber cork.
(a) iii, i, v, ii, vi, iv
(b) iii, v, vi, iv, i, ii
(c) i, iii, v, vi, ii, iv
(d) v, iv, iii, ii, i, vi

**40. Assertion (A):** In the manufacturing of common sugar, the syrup obtained does not have any colour
**Reason (R):** Coconut shell charcoal is used to decolourise brown colour of the syrup.

(a) Both A and R is incorrect.
(b) A is correct and R is incorrect.
(c) Both A and R are correct.
(d) A is incorrect and R is correct.

**41.** The properties of the product are different from those of the constituents, is called *[Madhy a Pradesh]*
(a) Mixture (b) Elements
(c) Compound (d) Acid.

**42.** A colourless gas $G_1$, produced on treating conc. $H_2SO_4$ with common salt is introduced into one end of a glass tube. Through the other end, another pungent smelling colourless gas, $G_2$ of molecular mass 17 is introduced. A white sublimate, S is produced inside the tube. which of the following statements is wrong? *[Odisha]*
(a) Both the gases $G_1$ and $G_2$ are water soluble.
(b) Sublimate S, contains covalent bond and ionic bond,
(c) Sublimate, S when treated with caustic soda liberates $G_2$ gas
(d) Aqueous solution of each $G_1$ and $G_2$ gas is acide in nature.

**43.** Which of the following statements are correct about properties of colloids? *[Panjab]*
(i) A colloid is a homogeneous mixture.
(ii) The size of particles of a colloid is too small to be individully seen by naked eye.
(iii) Colloids are big enough to scatter a beam of light passing through it and make its path visible.
(a) i, ii and are correct.
(b) ii and iii are correct.
(c) i and ii are correct.
(d) i and iii are correct.

**44.** What will be the mass/mass percentage of a solution containing 30 g of common salt in 220 g of water? *[Rajasthan]*
(a) 3% (b) 1.2% (c) 12% (d) 22%

**45.** Cheese is an example of which type of colloid? *[Rajasthan]*
(a) Gel (b) Foam (c) Sol (d) Solid sol

**46.** Which process is used to separate a mixture of two miscible liquids A and B having boiling points $56°C$ and $65°C$ respectively? *[Rajasthan]*
(a) Distillation (b) Fractional distillation
(c) Sublimation (d) Steam distillation

**47.** Priya and kartik wanted to study about diffusion among liquids. They took identical beakers and poured 100 mL of $H_2O$ in both the beakers. Priya heated the water to $50°C$ but kartik mainatained the water at room temperature. They both added 5 drops of ink into the beaker, what will they notice? *[Tamil Nadu]*
(a) Colour of ink spreads faster in priya's beaker.
(b) Colour of ink spreads faster in kartik's beaker.
(c) Colour of ink spreads at the same rate in both beakers.
(d) In both the beakers, ink drops settle down at the bottom without spreading.

**48.** Miscible liquid among the following is *[Telangana]*
(a) Alcohol in water (b) Milk
(c) Oil in water (d) Kerosene in water.

**49.** Which of the following is an element? *[Telangana]*
(a) Mercury (b) Ammonia
(c) Water (d) Glucose

**50.** The dyes of an ink can be separated by *[Telangana]*
(a) Filtration
(b) Sublimation
(c) Fractional distillation
(d) Chromatography.

## ANSWER KEY

| | | | | |
|---|---|---|---|---|
| **1.** b | **2.** d | **3.** a | **4.** d | **5.** d |
| **6.** b | **7.** a | **8.** d | **9.** c | **10.** a |
| **11.** c | **12.** c | **13.** d | **14.** a,b | **15.** b |
| **16.** c | **17.** d | **18.** d | **19.** b | **20.** b |
| **21.** a | **22.** a | **23.** b | **24.** b | **25.** b |
| **26.** a,b | **27.** c | **28.** b | **29.** c | **30.** a |
| **31.** d | **32.** b | **33.** d | **34.** c | **35.** b |
| **36.** b | **37.** a | **38.** d | **39.** b | **40.** d |





| | | | | |
|---|---|---|---|---|
| **41.** c | **42.** d | **43.** d | **44.** c | **45.** a |
| **46.** b | **47.** a | **48.** a | **49.** a | **50.** d |

## HINTS & SOLUTIONS

**1.Sol:** The solubility of solutes in water, generally, increases with temperature with a few exceptions.There are some solutes whose solubility decreases and for some it may remains constant.

**2.Sol:** Conceptual

**3.Sol:** $0°C = 273.15\,K$

**4.Sol:** Shaving cream is a type of colloid named foam.

**5.Sol:** Conceptual

**6.Sol:** As it is colloidal solution of fat dispersed in water.

**7.Sol:** Solution is homogeneous mixture.

**8.Sol:** Camphor is a substance that sublimes.

**9.Sol:** It is fact.

**10.Sol:** Conceptual

**11.Sol:** $\%\frac{w}{W} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$

$$= \frac{110}{550} \times 100 = 20\%$$

**12.Sol:** Particle size of suspension is more than 100 nm or greater than $10^{-5}$ cm.

**13.Sol:** Physical appearance cannot determine purity of a substance.

**14.Sol:** Conceptual

**15.Sol:** Face cream is an example of emulsion.

**16.Sol:** At 298 K or $25°C$, water is in liquid state.

**17.Sol:** Solids have a well- defined shape and volume. Liquids have definite volume and take the shape of the container whereas gases have no definite shape and volume, rather they fill the container.

**18.Sol:** Cheese is an example of gel in which dispersed phase is liquid and dispersing medium is solid.

**19.Sol:** $CO_2$ is gas at room temperature but $SiO_2$ is solid at room temperature. $CO_2$ contains $C = O$ bonds but $SiO_2$ does not contain $Si = O$ bonds. Both statements are true but reason is not the correct explanation of assertion. Due to giant molecular structure (3D arrangement) of $SiO_2$, it is solid but $CO_2$ is simple molecular structure, it is gas.

**20.Sol:** Conceptual

**21.Sol:** Conceptual

**22.Sol:** Strong intermolecular forces cause high melting point of a compound, e.g., ionic compounds are strong with high melting point.

**23.Sol:** The method for separation of mixture of common salt and ammonium chloride is sublimation as common salt is a non-sublimable substance.

**24.Sol:** Water exists in three states as ice (solid),water (liquid) and water vapour (gas)

**25.Sol:** % by mass

$$= \frac{\text{Mass of solute}}{\text{Mass of Solution}} \times 100$$

$$= \frac{20g}{100g} \times 100 = 20\%$$

**26.Sol:** We use distillation and fractional distillation process for separating miscible liquids depending on the difference of their boiling points.

**27.Sol:** In mud, dispersed phase is solid and dispersion medium is liquid. So it is sol type colloid.

**28.Sol:** In fog, liquid is dispersed phase and gas is dispersion medium.

**29.Sol:** $M = \frac{222 \times 2}{111 \times 100 \times 1000} \times 1000 = 0.04M$

**30.Sol:** Blood is a colloidal solution. The scattering of a beam of light by colloidal particles is called the Tyndall effect.

**31.Sol:** Increasing order of attraction between particles:
Oxygen(gas)<water (liquid)<sugar (solid).

**32.Sol:** Colloidal solutions show Tyndall effect. Starch solution is a colloidal solution.

**33.Sol:** Conceptual

**34.Sol:** $25°C = (25 + 273)K = 298K$

**35.Sol:** Milk is an emulsion (a colloidal solution in which both the dispersed phase and the

dispersion medium are liquids), it shows Tyndall effect.

**36.Sol:** $Molarity = \frac{\text{Number of moles of solute}}{\text{Volume of solution in litre}}$

$= \frac{\text{Weight of solute}}{\text{Molecular weight of solute} \times \text{Volume of solution in litre}}$

or $2 = \frac{x \times 1000}{40 \times 100}$ or, $x = 8g$

**37.Sol:** $2H_2 + O_2 \rightarrow 2H_2O$

4 g of hydrogen produces $2 \times 18 = 36$ g water

$\therefore$ 10 g of hydrogen produces

$= \frac{36 \times 10}{4} = 90$ g water

**38.Sol:** It is explained by Boyle's law. If deep sea fish are brought from the deep sea zone (where the pressure is high) to the surface (where the pressure is low), the volume of the gases in the swim bladder of fish increases causing the swim bladder to expand. The swim bladder can expand so much that it can crush other vital organs inside the fish and cause the fish to die.

**39.Sol:** Conceptual

**40.Sol:** In the manufacturing of common sugar, the syrup obtained is brown in colour. Coconut shell chorcoal is used to decolourise the sugar.

**41.Sol:** Conceptual

**42.Sol:** $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$

$HCl + NH_3 \rightarrow NH_4Cl$

$(G_1) \quad (G_2) \quad (S)$

**43.Sol:** A colloid is heterogeneous in nature.

**44.Sol:** Mass/mass percentage of a solution

$= \frac{\text{Mass of solute}(g)}{\text{Mass of solution}(g)} \times 100$

$= \frac{30}{(220+30)} \times 100 = \frac{30}{250} \times 100 = 12\%$

**45.Sol:** Conceptual

**46.Sol:** The difference in boiling points of liquids A and $B = (273+65) - (273+56) = 9K$

To separate a mixture of two or more miscible liquids for the difference in boiling points is less than 25 K, fractional distillation process is used.

**47.Sol:** An increase in temperature increases the speed at which molecules move.

**48.Sol:** Conceptual

**49.Sol:** Ammonia, water and glucose are compounds.

**50.Sol:** Conceptual







# CLASS XI CHEMISTRY KVPY-5

## PREVIOUS YEAR QUESTIONS

### d-BLOCK ELEMENTS

**1.** A sample of water was checked for suitability for drinking and was subjected to a chemical test. Pure zinc granules and sulphuric acid were added to the water sample. The effervescence that resulted from the reaction was bubbled through a tube containing lead acetate solution. A black precipitate appeared. The outgoing gas was subsequently passed through a heated copper tube, a black mirror appeared on the wall of the tube. The first and second black substances, respectively, are: **[2007]**

(a) HgS and CuS (b) PbS and CuS
(c) As and Hg (d) PbS and As

### ORGANIC CHEMISTRY - SOME BASIC PRINCIPLES & TECHNIQUES

**1.** The compound that can be purified by sublimation is : **[2008]**

(a) Ammonium Sulphate
(b) Calcium Carbonate
(c) Calcium Oxide
(d) Aluminium Chloride

**2.** The compound having a triple bond is **[2007]**

(a) Benzene (b) Cyclohexane
(c) Acetylene (d) Glucose

**3.** Among Butane, 1-Butene, 1-Butanol and butanal, the compound which is most polar is **[2008]**

(a) butane (b) 1-butene
(c) 1-butanol (d) butanal

**4.** Among ethanol, dimethyl ether, methanol, and propanal, the isomers are: **[2008]**

(a) ethanol, dimethyl ether, methanol and propanal
(b) ethanol and methanol
(c) ethanol, dimethyl ether, and methanol
(d) ethanol and dimethyl ether

**5.** The number of possible structural isomers of $C_3H_4$ is : **[2009]**

(a) 1 (b) 2 (c) 3 (d) 4

**6.** Among the four compounds (i) acetone, (ii) propanol, (iii) methyl acetate and (iv) propionic acid, the two that are isomeric are **[2009]**

(a) methyl acetate and acetone
(b) methyl acetate and propanol
(c) propionic acid and methyl acetate
(d) propionic acid and acetone

### CLASSIFICATION OF ELEMENTS & PERIODIC PROPERTIES

**1.** Among Li, Be, N and F, the element having the largest atomic radius, is: **[2008]**

(a) Li (b) Be (c) N (d) F

### HYDROGEN & ITS COMPOUNDS

**1.** The proof of oxidizing action of hydrogen peroxide in acid solution is in the formation of: **[2008]**

(a) $O_2$
(b) $H_2O$
(c) both $H_2O$ and $O_2$
(d) both $H_3O^+$ and $O_2$

**2.** The pair of metals which will produce hydrogen gas on reaction with acid is: **[2008]**

(a) Mg, Cu (b) Mg, Ag
(c) Zn, Pb (d) Cu, Zn

### p-BLOCK ELEMENTS (XI)

**1.** One of the major components in compressed natural gas (CNG) is: **[2008]**

(a) carbon dioxide (b) acetylene
(c) methane (d) water gas

## REDOX REACTIONS

**1.** In the reaction of $FeSO_4$ with $K_2Cr_2O_7$ in the presence of an acid, the changes in the formal oxidation numbers of Cr and Fe, respectively, are: **[2008]**

(a) 1 and 5 (b) 3 and 1
(c) 5 and 1 (d) 1 and 3

**2.** In the reaction $SO_2 + 2H_2S \longrightarrow 3S + 2H_2O$, the substance that is oxidized is **[2009]**

(a) $SO_2$ (b) $H_2O$ (c) S (d) $H_2S$

**3.** The reaction $ZnO + C \rightarrow Zn + CO$ is an example of a **[2007]**

(a) Combination reaction
(b) Reduction-oxidation reaction
(c) Displacement reaction
(d) Decomposition reaction

## CHEMICAL BONDING

**1.** The element X which forms a stable product of the type $XCl_4$ is **[2009]**

(a) Al (b) Na (c) Ca (d) Si

**2.** The pair in which the first compound is ionic and the second compound is covalent, is **[2009]**

(a) $Fe(OH)_2, CH_3OH$

(b) $CH_3OH, CH_3CH_2OH$

(c) $Fe(OH)_2, Cu(OH)_2$

(d) $Ca(OH)_2, Cu(OH)_2$

## ANSWER KEY

### d-BLOCK ELEMENTS
**1.** b

### ORGANIC CHEMISTRY- SOME BASIC PRINCIPLES & TECHNIQUES
**1.** a **2.** c **3.** c **4.** d **5.** b
**6.** c

### CLASSIFICATION OF ELEMENTS & PERIODIC PROPERTIES
**1.** a

### HYDROGEN & ITS COMPOUNDS
**1.** c **2.** c

### p-BLOCK ELEMENTS (XI)
**1.** c

### REDOX REACTIONS
**1.** b **2.** d **3.** b

### CHEMICAL BONDING
**1.** d **2.** a

## HINTS & SOLUTIONS

### d-BLOCK ELEMENTS
**1.Sol:**

$$Zn + 2H_2SO_4(\text{conc.}) \rightarrow ZnSO_4 + SO_2(g) + 2H_2O$$

$$(CH_3COO)_2Pb + SO_2 \rightarrow \underset{(\text{BlackPrecipitate})}{PbS}$$

$$Cu + SO_2 \rightarrow \underset{(\text{Black mirror})}{CuS} + O_2$$

### ORGANIC CHEMISTRY - SOME BASIC PRINCIPLES & TECHNIQUES
**1.Sol:** Sublimable compounds like ammonium sulphate are purified by sublimation method.

**2.Sol:** Acetylene $(CH \equiv CH)$ has a triple bond.

**3.Sol:** 1 - Butanol is slightly polar (having an -OH group attached), more polar than butanal. Because of the slight polarity, there are stronger intermolecular forces between the 1- Butanol molecules together.

**4.Sol:** Ethanol $(C_2H_5OH)$ and dimethyl ether $(CH_3 - O - CH_3)$ have same molecular formula.

**5.Sol:** $CH_3 - C \equiv CH$ (Propyne) and △ are two possible structural isomers of $C_3H_4$

**6.Sol:** Propionic acid and methyl acetate both have same molecular formula $(C_3H_6O_2)$.





### CLASSIFICATION OF ELEMENTS & PERIODIC PROPERTIES
**1.Sol:** For the elements belonging to one period, increase in atomic number results in decrease in atomic radius. So 'Li' has the largest atomic radius.

### HYDROGEN & ITS COMPOUNDS
**9.Sol:** $2H_2O_2 \longrightarrow 2H_2O + O_2$

**10.Sol:** Zn and Pb are placed above hydrogen in the metal activity series, so they will produce hydrogen gas with dilute acids.

### p-BLOCK ELEMENTS (XI)
**1.Sol:** Conceptual

### REDOX REACTIONS
**1.Sol:**

$$Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$$

Change in oxidation number of Cr is = 6-3 =3
Change in oxidation number of Fe is = 3 -2 =1

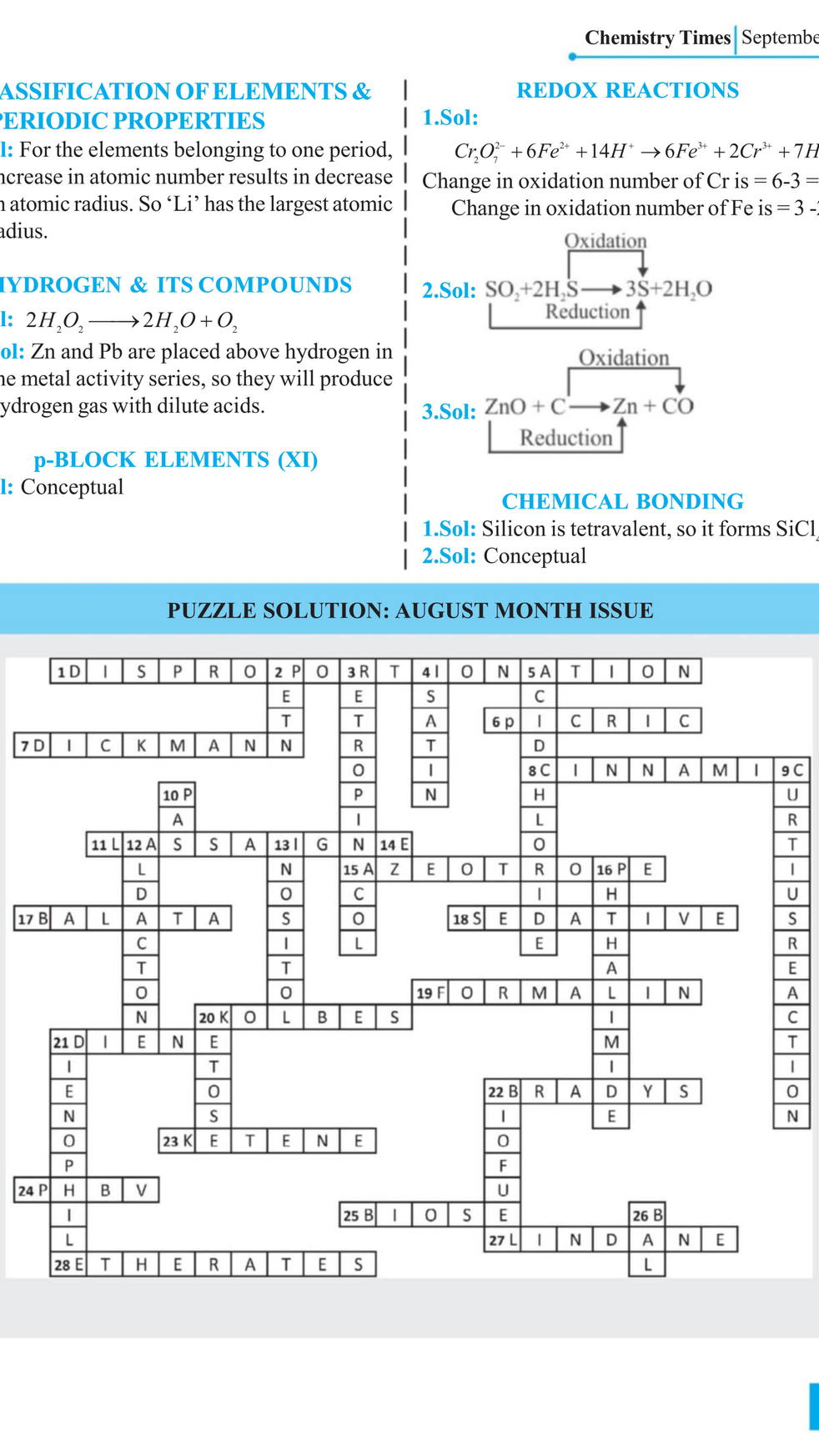
**2.Sol:** $SO_2 + 2H_2S \longrightarrow 3S + 2H_2O$ (Oxidation: $H_2S \rightarrow S$; Reduction: $SO_2 \rightarrow S$)

**3.Sol:** $ZnO + C \longrightarrow Zn + CO$ (Oxidation: $C \rightarrow CO$; Reduction: $ZnO \rightarrow Zn$)

### CHEMICAL BONDING
**1.Sol:** Silicon is tetravalent, so it forms $SiCl_4$

**2.Sol:** Conceptual

## PUZZLE SOLUTION: AUGUST MONTH ISSUE



# NSE - CHEMISTRY

## CLASS XI

**1.** Which of the pair of orbitals have electronic density along the axis?

(a) $d_{xz}, d_{yz}$ (b) $d_{xy}, d_{z^2}$

(c) $d_{xy}, d_{yz}$ (d) $d_{x^2-y^2}, d_{z^2}$

**2.** Which of the following is used in photoelectric cell?

(a) Lithum (b) Francium

(c) Cesium (d) Sodium

**3.** Which of the following pairs of electron excluded from one atom?

(a) $n=1, l=0, s=1/2$ and $n=1, l=0, m=0, s=-1/2$

(b) $n=2, l=2, s=1/2$ and $n=2, l=1, m=-1, s=+1/2$

(c) $n=2, l=0, s=+1/2$ and $n=2, l=0, m=0, s=+1/2$

(d) $n=3, l=2, s=1/2$ and $n=3, l=0, m=0, s=+1/2$

**4.** The de-Broglie wavelength associated with the particle is

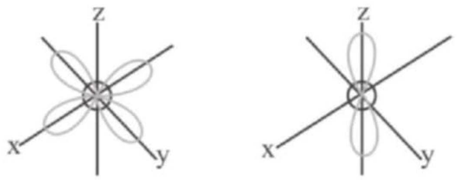
(a) directly proportional to its momentum

(b) directly proportional to its energy

(c) directly proportional to its velocity

(d) inversely proportional to its momentum

**5.** The figure show the angular probability distribution of




(a) $d_{xy}, d_{yz}$ (b) $d_{x^2-y^2}, d_{z^2}$

(c) $d_{xy}, d_{xz}$ (d) None of the above

**6.** Given the set of quantum number for a multi electron atom; 2, 0, 0, 1/2 and 2, 0, 0, -1/2. What is the next higher allowed set of n and l quantum numbers for this atom in its ground state?

(a) $n=2, l=0$ (b) $n=3, l=0$

(c) $n=2, l=1$ (d) $n=3, l=1$

**7.** Which element exhibit the photoelectric effect with light of the longest wavelength?

(a) K (b) Ca (c) Mg (d) Rb

**8.** Which set of orbitals is listed in the sequential order of filling in a many electron atom?

(a) 3d, 4p, 5s (b) 3d, 4s, 4p

(c) 3s, 3p, 3d (d) 4p, 4d, 4s

**9.** The designation of an orbital with $n=6$ and $l=4$ is

(a) 6s (b) 6d (c) 6g (d) 6f

**10.** The maximum number of 3d electrons that can have $s=-1/2$ are

(a) 5 (b) 3 (c) 7 (d) 10

**11.** Which metal requires the least energy to exhibit photoelectric effect?

(a) Cs (b) Cu (c) Ca (d) Hg

**12.** Which of these has unpaired electron?

(1) $O_2$ (2) $O_2^-$ (3) $O_2^{2-}$

(a) (1) and (2) (b) (3) only

(c) (2) only (d) (1) and (3) only

**13.** The hydrogen line spectrum provides evidence for the

(a) Heisenberg's uncertainty pricniple

(b) wave like properties of light

(c) quantized nature of atomic energy states

(d) diatomic nature of $H_2$

**14.** What is the number of unpaired electrons in a manganese atom (Z=25) in its lowest energy states?

(a) 5 (b) 3 (c) 1 (d) 7

**15.** Ions with $1s^2 2s^2 2p^6 3s^2 3p^6$ would not be present in which aqueous solution?

(a) KBr (b) NaCl (c) NaF (d) $CaI_2$

**16.** Calculate the wavelength of light required to break the bond between 2 chlorine atoms in a chlorine molecules. The Cl - Cl bond energy is 243 kJ/mol

(a) $8.18\times10^{-31}$ m (b) $4.93\times10^{-7}$ m

(c) $6.26\times10^{21}$ m (d) $4.11\times10^{-6}$ m

**17.** Which configuration is not allowed for either a neutral atom or an ion in its ground state?

(a) $1s^2, 2s^2 2p^3$

(b) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^1$

(c) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^3$

(d) $1s^2, 2s^1 2p^6$

**18.** Spectral lines similar to H-atoms are given by

(a) $He^+$, $Li^{2+}$, $Be^{3+}$, D (b) He, $Li^+$, $Be^{2+}$, D

(c) $He^+$, $Li^+$, $Be^{2+}$, D (d) He, Li, Be, D

**19.** If aufbau rule is not followed in filling of sub-orbitals then block of the element will be change in

(a) K (19) (b) Sc (21) (c) V (23) (d) Ni (28)

**20.** Number of photons of light of wavelength 4000 A° required to provide 1000 J of energy is

(a) $2.01\times10^{18}$ (b) $12.01\times10^{31}$

(c) $1.35\times10^{17}$ (d) None of these

**21.** The splitting of spectural lines under the influence of an electric field is called

(a) Raman effect (b) Zeeman effect

(c) Compton effect (d) Stark effect

**22.** Azimuthal quantum number value for dumb bell shaped orbital is

(a) -1 (b) 1 (c) 0 (d) 2

**23.** An isotone of $^{76}_{32}Ge$

(a) $^{77}_{33}Se$ (b) $^{77}_{33}As$ (c) $^{72}_{32}Ge$ (d) $^{79}_{34}Se$

**24.** Planck's constant value in joules-sec is

(a) $6.6252\times10^{-27}$ (b) $6.6252\times10^{-34}$

(c) $6.023\times10^{23}$ (d) $3.1444\times10^{-10}$

**25.** Correct set of all four quantum numbers for an unpaired electron for $3d^9$ is

(a) $3, 2, +2, +\frac{1}{2}$ (b) $3, 2, -3, -\frac{1}{2}$

(c) $3, 3, +2, +\frac{1}{2}$ (d) $3, 3, +2, -\frac{1}{2}$

**26.** Isosteres are compounds having similar geometry and isoelectronic species are species having the same number of electrons. The pair of species $CO_2$ and $NO_2^+$ is

(a) Isosteric and isoelectronic

(b) Isosteric but not isoelectronic

(c) Isoelectronic but not isosteric

(d) Neither isoelectric nor isosteric

**27.** The ratio of energy of a photon of wavelength 2000 Å to that of one with wavelength 4000 Å is

(a) $\frac{1}{4}$ (b) 4 (c) $\frac{1}{2}$ (d) 2

**28.** Wavelength associated with electron motion

(a) Increase with increase in the speed of electrons

(b) Remains same irrespective of speed of electron

(c) Decrease with increase of the speed of electron

(d) changes with the atomic number of atom to which it belongs

**29.** The radiations having highest amount of energy has

(a) $\lambda = 3$ nm (b) $v = 3\times10^{-8} s^{-1}$

(c) $\lambda = 3$ Å (d) $\lambda = 3$ pm

**30.** The three quantum numbers, *n*, *l*, *m* corresponding to the valence electron of Rubidium ( Z = 37) are

(a) 5, 0, 0 (b) 5, 1, 0 (c) 5, 0, 1 (d) 5, 1

**31.** The set of quantum numbers $n = 2, l = 2$, $m = 0$, for an atomic system
(a) denotes a 2p electron
(b) refers to an atom in 2d-orbitals
(c) is not allowed
(d) describes one of the 7f-electrons

**32.** The number of unpaired electrons in the scandium atom is
(a) 2 (b) 1 (c) 0 (d) 3

## ANSWER KEY

| | | | | |
|---|---|---|---|---|
| **1.** d | **2.** c | **3.** b | **4.** d | **5.** b |
| **6.** c | **7.** d | **8.** a | **9.** c | **10.** a |
| **11.** a | **12.** a | **13.** c | **14.** a | **15.** c |
| **16.** a | **17.** d | **18.** a | **19.** a | **20.** d |
| **21.** d | **22.** b | **23.** b | **24.** b | **25.** a |
| **26.** a | **27.** d | **28.** c | **29.** d | **30.** a |
| **31.** c | **32.** b | | | |

## HINTS & SOLUTIONS

**1.Sol:** In case of $d_{xy}$, $d_{yz}$ and $d_{xz}$, lobes (electron density) present between the axes.

**2.Sol:** Due to high electropositive nature of 'Cs' element

**3.Sol:** 'n' and *'l'* values cannot be same for an electron in any atom.

**4.Sol:** $\lambda = h/p$
where 'p' is momentum

**5.Sol:** Conceptual

**6.Sol:** Given quantum numbers represents 2s orbital two electrons. The next energy level is 2p *i.e.,* n = 2, *l* = 1

**7.Sol:** Lower is the energy required to show photoelectric effect longest is the wave length.

**8.Sol:** According to (n + *l*) rule

**9.Sol:** The value of *'l'* for g - orbital is 4. So, the orbital notation is 6g

**10.Sol:** Maximum number of electrons filled in d - orbital are 10. Out of these, 5 electrons have 's' value +1/2 remaining have -1/2

**11.Sol:** Due to high electropositive nature of 'Cs' element.

**12.Sol:** $O_2$ has two unpaired electrons and $O_2^-$ has one unpaired electron according MOT.

**13.Sol:** Conceptual

**14.Sol:** Mn (Z = 25) - $[Ar]4s^23d^5$

**15.Sol:** Electronic configuration of $Na^+$ and $F^-$ ions is same *i.e.,* $1s^22s^22p^6$

**16.Sol:** $\lambda = hc/E$

$= 6.626\times10^{-34}\times3\times10^{8} / 243\times10^{3}$

$= 8.18\times10^{-31}$ m

**17.Sol:** Conceptual

**18.Sol:** One electron containing species gives spectrum like as H- atom.

**19.Sol:** Conceptual

**20.Sol:** $n = E\lambda/hc$

$= 1000\times4000\times10^{-10}/6.626\times10^{-34}\times3\times10^{8}$

$= 0.2\times10^{22} = 2\times10^{21}$

**21.Sol:** Conceptual

**22.Sol:** p-orbital shape is dumbell and the value of *'l'* is 1

**23.Sol:** Isotones possesses same number of neutrons *i.e.,* A - Z (or Mass number - Atomic number)

**24.Sol:** Conceptual

**25.Sol:** Conceptual

**26.Sol:** Conceptual

**27.Sol:** $E_1/E_2 = \lambda_2/\lambda_1 = 4000/2000 = 2$

**28.Sol:** Conceptual

**29.Sol:** Energy is inversely proportional to the wave length

**30.Sol:** Rubidium, Rb (Z = 37) = $[Kr]5s^1$
n = 5, *l* = 0 and m = 0

**31.Sol:** 'n' and *'l'* values never be same. The values of *'l'* are lies between 0 to (n-1).

**32.Sol:** Sodium, Na = [Ne] $3s^1$.
Scandium = [Ar] $4s^23d^1$
Only one unpaired electron present in 3s orbtial.





# Previous years NEET/AIPMT Questions

## BIO-MOLECULES

**1.** The difference between amylose and amylopectin is **[2018]**
(a) Amylopectin have $1\rightarrow4\alpha-$ linkage and $1\rightarrow6\beta-$ linkage
(b) Amylose is made up of glucose and galactose
(c) Amylose have $1\rightarrow4\alpha-$ linkage and $1\rightarrow6\beta-$ linkage
(d) Amylopectin have $1\rightarrow4\alpha-$ linkage and $1\rightarrow6\alpha-$ linkage.

**2.** Which of the following compounds can form a zwitter ion? **[2018]**
(a) Benzoic acid (b) Glycine
(c) Acetanilide (d) Aniline

**3.** The correct statement regarding RNA and DNA, respectively is: **[2016]**
(a) The sugar component in RNA is ribose and the sugar component in DNA is 2'-deoxyribose.
(b) The sugar component in RNA is arabinose and the sugar component in DNA is ribose.
(c) The sugar component in RNA is arabinose and the sugar component in DNA is 2' -deoxyribose.
(d) The sugar component in RNA is 2'-deoxyribose and the sugar component in DNA is arabinose.

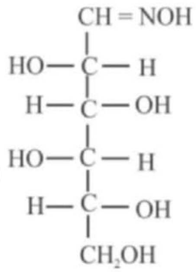
**4.** Which one given below is a non-reducing sugar? **[2016]**
(a) Lactose (b)Glucose
(c) Sucrose (d) Maltose

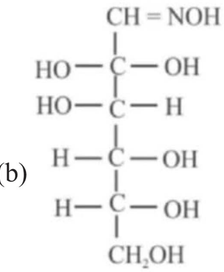
**5.** In a protein molecule various amino acids are linked together by: **[2016]**
(a) β -glycosidic bond (b) peptide bond
(c) dative bond (d) α -glycosidic bond

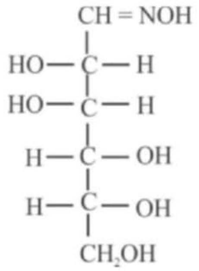
**6.** The function of "Sodium pump" is a biological process operating in each and every cell of all animals. Which of the following biologically important ions is also a constituent of this pump? **[2015]**
(a) $Ca^{2+}$ (b) $Mg^{2+}$ (c) $K^+$ (d) $Fe^{2+}$

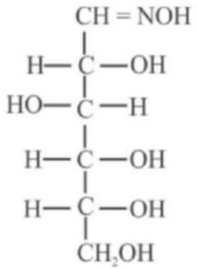
**7.** Which of the following hormones is produced under the conditions of stress which stimulate glycogenolysis in the liver of human beings? **[2014]**
(a) Adrenaline (b) Estradiol
(c) Thyroxine (d) Insulin

**8.** D (+) glucose reacts with hydroxylamine and yields an oxime. The structure of the oxime would be: **[2014]**

(a)



(b)


(c) 


(d) 


**9.** Which one of the following sets of monosaccharides form sucrose? **[2012]**

(a) α -D-Galactopyranose and α -D-Glucopyranose

(b) α -D-Glucopyranose and β -D-fructofuranose

(c) α -D-Glucopyranose and α -D-fructofuranose

(d) β -D-Glucopyranose and β -D-fructopyranose

**10.** Deficiency of vitamin $B_1$ causes the disease: **[2012]**

(a) Convulsions (b) Beri-Beri
(c) Cheilosis (d) Sterility

**11.** Which one of the following statements is not true regarding (+) Lactose? **[2011]**

(a) (+) Lactose is a β -glycoside formed by the union of a molecule of D(+) glucose and a molecule of D(+) galactose.

(b) (+) Lactose is a reducing sugar and does not exhibit mutarotation.

(c) On hydrolysis (+) Lactose gives equal amount of D(+) glucose and D(+) galactose.

(d) (+) Lactose, $C_{12}H_{22}O_{11}$ contains 8-OH groups.

**12.** Find the hydrolysis product of maltose **[2011]**

(a) α -D-fructose + α -D-galactose
(b) α -D-mannose + α -D-galactose
(c) α -D-glucose + α -D-glucose
(d) α -D-glucose + α -D-fructose

**13.** Which one of the following does not exhibit the phenomenon of mutarotation? **[2010]**

(a) (+) Maltose (b) (-) Fructose
(c) (+) Sucrose (d) (+) Lactose

**14.** Fructose reduces Tollen's reagent due to: **[2010]**

(a) Secondary alcoholic group
(b) Enolisation of fructose followed by conversion to aldehyde by base
(c) Primary alcoholic group
(d) Asymmetric carbon atoms

**15.** The segment of DNA which acts as the instrumental manual for the synthesis of the protein is: **[2009]**

(a) Ribose (b) Gene
(c) Nucleoside (d) Nucleotide

**16.** In DNA, the complimentary bases are: **[2008]**

(a) uracil and adenine; cytosine and guanine
(b) adenine and thymine; guanine and cytosine
(c) adenine and thymine; guanine and uracil
(d) adenine and guanine; thymine and cytosine

**17.** DNA and RNA are chiral molecules due to the presence of: **[2007]**

(a) D-sugar component
(b) L-sugar component
(c) chiral bases
(d) phosphate ester unit

**18.** The vitamin which is water soluble is: **[2007]**

(a) Vitamin K (b) Vitamin B
(c) Vitamin E (d) Vitamin D

## HALOALKANES &HALOARENS

**1.** Which of the following reaction (s) can be used for the preparation of alkyl halides? **[2015]**

(I) $CH_3CH_2OH + HCl \xrightarrow{anh.ZnCl_2}$

(II) $CH_3CH_2OH + HCl \longrightarrow$

(III) $(CH_3)_3COH + HCl \longrightarrow$

(IV) $(CH_3)_3COH + HCl \xrightarrow{anh.ZnCl_2}$

(a) (I) and (IV) only (b) (I) and (II) only
(c) (IV) only (d) (III) and (IV) only

**2.** In an $S_N^1$ reaction on chiral centers, there is: **[2015]**

(a) 100% recemization
(b) inversion more than retention leading to partial recemization
(c) 100% retention
(d) 100% inversion

**3.** What products are formed when the following compounds are treated with $Br_2$ in the presence of $FeBr_3$? **[2014]**




**4.** In the following sequence of reactions

$CH_3 - Br \xrightarrow{KCN} A \xrightarrow{H_3O^+} B \xrightarrow[Ether]{LiAlH_4} C$

the end product is: **[2012]**

(a) Acetone (b)Methane
(c) Acetaldehyde (d) Ethyl alcohol

**5.** Following compounds are given: **[2010]**

(i) $CH_3CH_2OH$ (ii) $CH_3COCH_3$

(iii) $CH_3CH(OH)CH_3$ (iv) $CH_3OH$

Which of the above compond(s), on being warmed with iodine solution and NaOH, will give iodoform?

(a) (i), (ii) and (iii) (b) (i) and (ii)
(c) (i), (iii) and (iv) (d) Only (ii)

**6.** In the following reaction: **[2010]**

$C_6H_5CH_2Br \xrightarrow[2.H_3O]{1.Mg,Ether} X$; the product 'X' is:

(a) $C_6H_5CH_3$ (b) $C_6H_5CH_2CH_2C_6H_5$

(c) $C_6H_5CH_2OCH_2C_6H_5$

(d) $C_6H_5CH_2OH$

**7.** Which one is most reactive towards $S_N^1$ reactions? **[2010]**

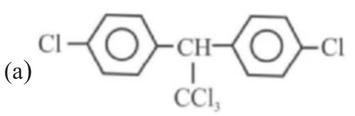
(a) $C_6H_5C(CH_3)(C_6H_5)Br$

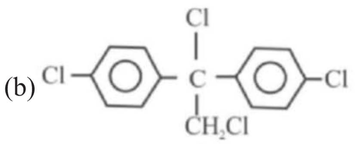
(b) $C_6H_5CH_2Br$

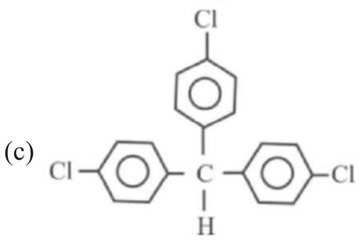
(c) $C_6H_5CH(C_6H_5)Br$

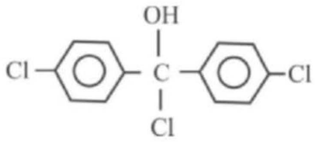
(d) $C_6H_5CH(CH_3)Br$

**8.Sol:** Trichloroacetaldehyde, $CCl_3CHO$ reacts with chlorobenzene in presence of sulphuric acid and produces: **[2009]**

(a) 


(b) 


(c) 

(d) 

## ORGANIC COMPOUNDS CONTAINING NITROGEN

**1.** Nitration of aniline in strong acidic medium also gives m-nitroaniline because **[2018]**

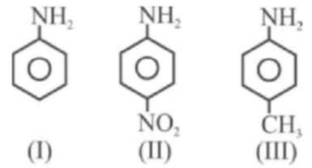
(a) In absence of substituents nitro group always goes to m-position.

(b) In acidic (strong) medium aniline is present as anilinium ion.

(c) In electrophilic substitution reactions amino group is meta directive.

(d) In spite of substituents nitro group always goes to only m-position.

**2.** The correct increasing order of basic strength for the following compounds is : **[2017]**



(I) (II) (III)

(a) III < I < II (b) III < II < I

(c) II < I < III (d) II < III < I

**3.** Which of the following reactions is appropriate for converting acetamide to methanamine? **[2017]**

(a) Hoffmann hypobromamide reaction

(b) Stephens reaction

(c) Gabriel phthalimide synthesis

(d) Carbylamine reaction

**4.** The correct statement regarding the basicity of arylamines is: **[2016]**

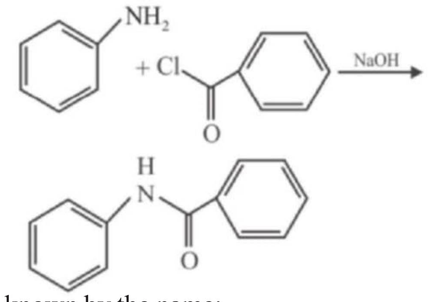
(a) Arylamines are generally more basic than alkyl amines, because the nitrogen atom in arylamines is sp-hybridized.

(b) Arylamine are generally less basic than alkyl amine because the nitrogen lone-pair electrons are delocalised by interaction with the aromatic ring $\pi$-electron system.

(c) Arylamines are generally more basic than alkyl amines because the nitrogen lone-pair electrons are not delocalised by interaction with the aromatic ring $\pi$-electron system.

(d) Arylamines are generally more basic than alkyl amines because of aryl group.

**5.** The following reaction **[2015]**



is known by the name:

(a) Acetylation reaction

(b) Schotten-Baumann reaction

(c) Friedel-Crafts reaction (d) Perkin's reaction

**6.** Method by which Aniline cannot be prepared is: **[2015]**

(a) reduction of nitrobenzene with $H_2 / Pd$ in ethanol

(b) potassium salt of phthalimide treated with chlorobenzene followed by hydrolysis with aqueous NaOH solution

(c) hydrolysis of phenylisocyanide with acidic solution

(d) degradation of benzamide with bromine in alkaline solution

**7.** The electrolytic reduction of nitrobenzene in strongly medium produces **[2015]**

(a) azobenzene (b) aniline

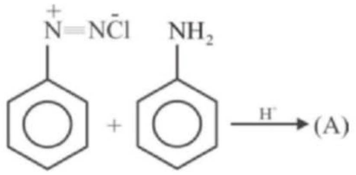
(c) p-aminophenol (d) azoxybenzene

**8.** Which of the following will be most stable diazonium salt $RN_2^+X^-$? **[2014]**

(a) $C_6H_5N_2^+X^-$ (b) $CH_3N_2^+X^-$

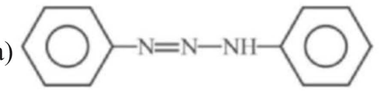
(c) $CH_3CH_2N_2^+X^-$ (d) $C_6H_5CH_2N_2^+X^-$

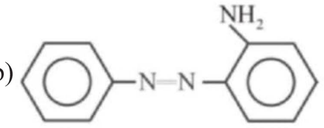
**9.** In the following reaction, the product (A) is **[2014]**

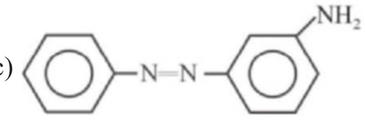


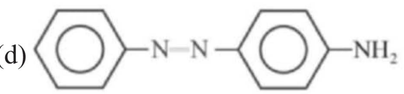


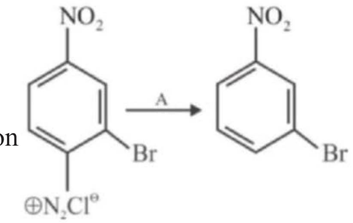


(a) 

(b) 

(c) 

(d) 

**10.** In the reaction 

A is: **[2013]**

(a) $Cu_2Cl_2$ (b) $H_3PO_2$ and $H_2O$

(c) $H^+ / H_2O$ (d) $HgSO_4 / H_2SO_4$

**11.** Nitrobenzene on reaction with conc. $HNO_3 / H_2SO_4$ at $80-100^oC$ forms which one of the following products? **[2012]**

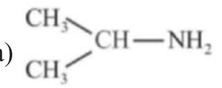
(a) 1, 3-Dinitrobenzene

(b) 1, 4- Dinitrobenzene

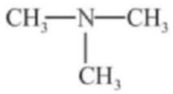
(c) 1, 2, 4-Trinitrobenzene

(d) 1, 2-Dinitrobenzene

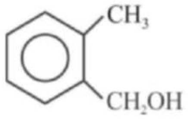
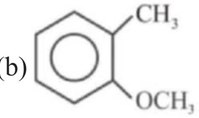
**12.** An organic compound $(C_3H_9N)$ (A), when treated with nitrous acid, gave an alcohol and $N_2$ gas was evolved (A) on warming with $CHCl_3$ and caustic potash gave (C) which on reduction gave isopropylmethylamine. Predict the structure of (A). **[2012]**

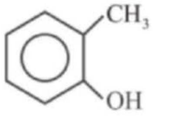
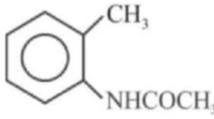
(a) 

(b) $CH_3CH_2 - NH - CH_3$

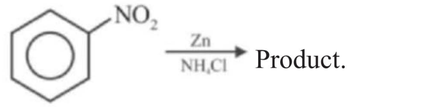
(c)  (d) $CH_3CH_2CH_2 - NH_2$

**13.** Which one of the following is most reactive towards electrophilic reagent? **[2011]**

(a)  (b) 

(c)  (d) 

**14.** What is the product obtained in the following reaction? **[2011]**



(a)  (b) 

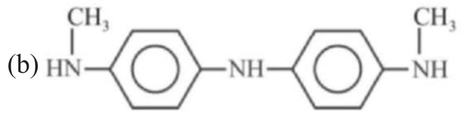
(c) 

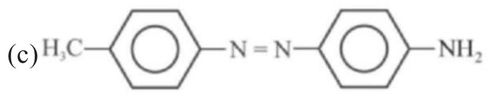
(d) 

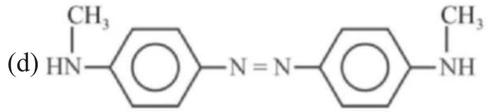
**15.** Aniline in a set of the following reaction yielded a coloured compound Y. The compound Y is **[2010]**



(a) 

(b) 

(c) 

(d) 

**16.** Which of the following statement about amines is false? **[2010]**

(a) Alkylamines are stronger base than aryl amines.

(b) Alkylamines react with nitrous acid to produce alcohols.

(c) Arylamines react with nitrous acid to produce phenols.

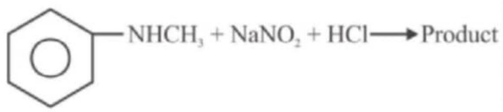
(d) Alkylamines are stronger bases than ammonia.

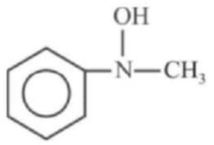
**17.** Nitrobenzene can be prepared from benzene by using a mixture of conc. $HNO_3$ and conc. $H_2SO_4$. In the mixture, nitric acid acts as a/an: **[2009]**

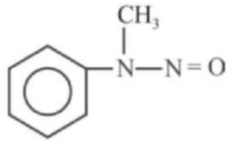
(a) catalyst (b) reducing agent

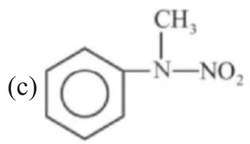
(c) acid (d) base

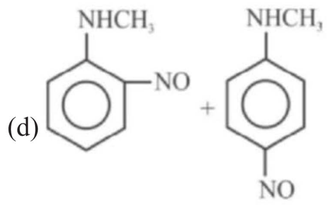
**18.** Predict the product: **[2009]**



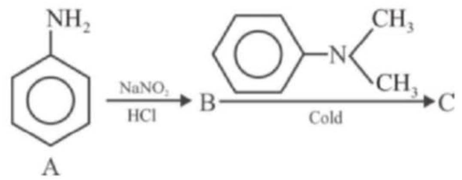
(a) 

(b) 

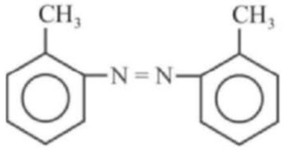
(c) 

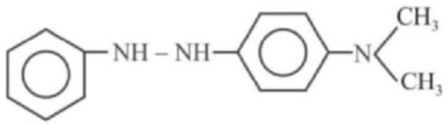
(d) 

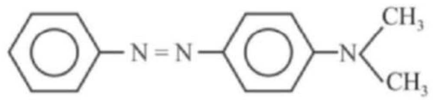
**19.** In a reaction of aniline a coloured product C was obtained.

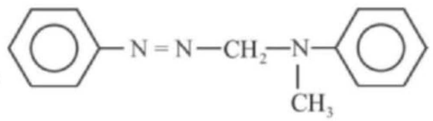


The structure of C would be: **[2008]**

(a) 

(b) 

(c) 

(d) 

**20.** Which of the following on reduction with $LiAlH_4$ gives a secondary amine? **[2007]**

(a) $CH_3NC$ (b) $CH_3CONH_2$

(c) $CH_3CN$ (d) $CH_3NO_2$





## ANSWER KEY

### BIO-MOLECULES

| | | | | |
|---|---|---|---|---|
| **1.** d | **2.** b | **3.** a | **4.** c | **5.** b |
| **6.** c | **7.** a | **8.** d | **9.** b | **10.** b |
| **11.** b | **12.** c | **13.** c | **14.** b | **15.** b |
| **16.** b | **17.** a | **18.** b | | |

### HALOALKANES & HALOARENS

| | | | | |
|---|---|---|---|---|
| **1.** a | **2.** b | **3.** c | **4.** d | **5.** a |
| **6.** a | **7.** a | **8.** a | | |

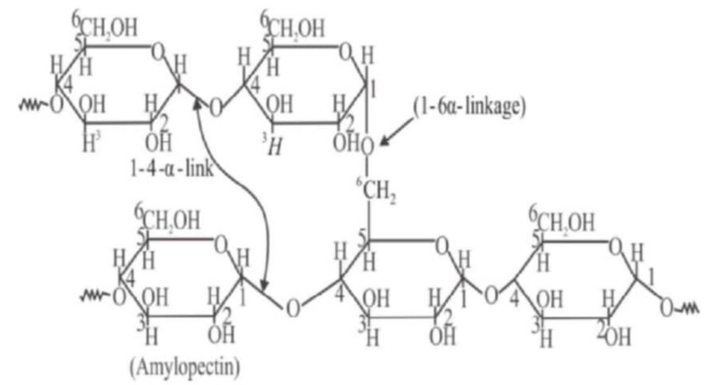
### ORGANIC COMPOUNDS CONTAINING NITROGEN

| | | | | |
|---|---|---|---|---|
| **1.** b | **2.** c | **3.** a | **4.** b | **5.** b |
| **6.** b | **7.** c | **8.** a | **9.** d | **10.** b |
| **11.** a | **12.** a | **13.** c | **14.** b | **15.** a |
| **16.** b | **17.** b | **18.** b | **19.** c | **20.** a |

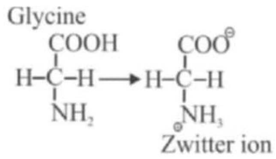
## HINTS & SOLUTIONS

### BIO-MOLECULES

**1. Sol:**



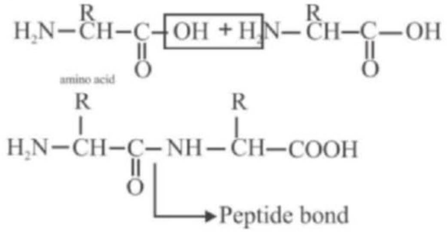

**2.Sol:**




**3.Sol:** DNA - Deoxyribose sugar
RNA - Ribose sugar

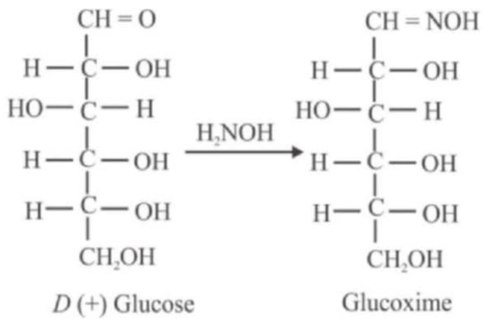
**4.Sol:** Sucrose is non-reducing sugar. (If both the anomeric carbon are boned to each other, then such sugars are called nonreducing)

**5.Sol:**




**6.Sol:** $K^+$

**7.Sol** Adrenaline is a hormone produced by adrenal glands during high stress or exciting situations. This powerful hormone is part of the human body's acute stress response system, also called the fight or flight response.



**9.Sol:** Set of monosaccharides α -D-glucopyranose and β -D-fructofuranose forms sucrose.

**10.Sol:** Disease beri-beri is caused by the deficiency of vitamin $B_1$.

**11.Sol:** (+) Lactose on hydrolysis yields equal amount of D(+) glucose and D(+) galactose. These two monosachharides are joined by β-1, 4-glucosidic linkage. (+) Lactose contains hemiacetal group and thus reducing sugar. Also it exhibits mutarotation.

**12.Sol:** $\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{or maltase}]{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Glucose}}{C_6H_{12}O_6}$

**13.Sol:** Sucrose does not show mutarotation.

**14.Sol:** In presence of alkali, fructose is converted into mixture of mannose and glucose showing enolisation. Glucose then reduces Tollen's reagent.

**15.Sol:** Genes are responsible for the synthesis of protein.

**16.Sol:** In DNA, paring of complementary bases,
(i) Thymine (T) with Adenine (A) through two H- bonds and
(ii) Cytosine (C) and Guanine (G) through three H - bonds.

**17. Sol:** Sugar present in DNA is 2-deoxy D (-) - ribose and that in RNA is D-(-)-ribose, and both are chiral.

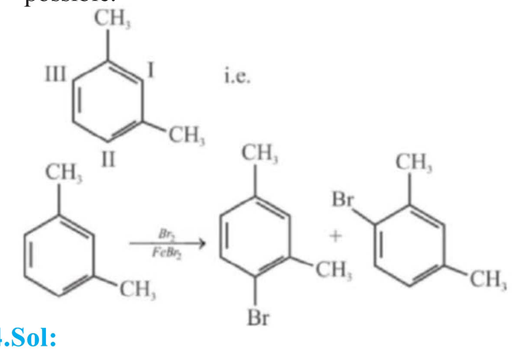
**18. Sol:** Vitamin B is soluble in water.

## HALOALKANES & HALOARENS

**1.Sol:** (I) and (IV) can be used due to presence of anhydrous $ZnCl_2$ (III) gives alkyl halides due to formation of more stable carbocation.

**2. Sol:** $S_N^1$ reaction gives racemic mixture with slight predominance of that isomer which corresponds to inversion because $S_N^1$ also depends upon the degree of 'shielding' of the front side of the reacting carbon.

**3. Sol:** Methyl group is ortho, para directing but due to steric hindrance effect, generated by two $CH_3$ groups substitution will not take place on position (I). Hence only two products are possible.



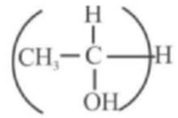
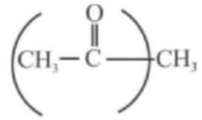

i.e.

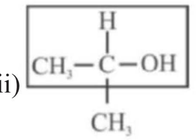
**4.Sol:**

$$CH_3Br + KCN \xrightarrow[-KBr]{KCN} CH_3CN \xrightarrow{H_3O^+} CH_3COOH$$
(A) (B)

$$CH_3CH_2OH \xleftarrow{LiAlH_4}$$
ethylalcohol (C)

**5.Sol:** Carbonyl group of type $CH_3-\overset{O}{\overset{\|}{C}}\sim$ and alcohols of types $CH_3-\underset{H}{\overset{OH}{C}}\sim$ give iodoform test.

(i)  (ii) 

(iii)  (iv) $CH_3OH$ doesn't give

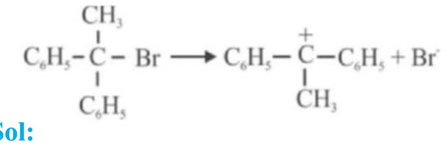
**6.Sol:** $C_6H_5.CH_2Br \xrightarrow{Mg/ether} C_6H_5.CH_2MgBr$

$$\xrightarrow{H_3O^+} C_6H_5.CH_3 + MgBr(OH)$$

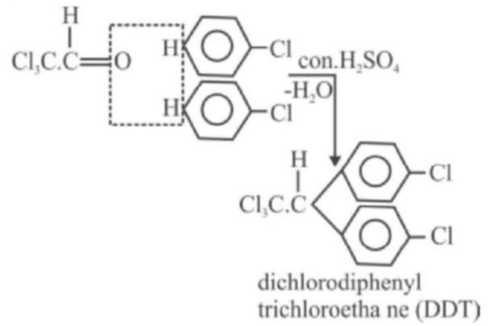
**7.Sol:** $S_N^1$ reaction involves the formation of carbocations, hence higher the stability of carbocation, more will be the reactivity of the parent alkyl halide. Thus tertiary carbocation formed from (c) is stabilised by two phenyl groups and one methyl group, hence most stable.





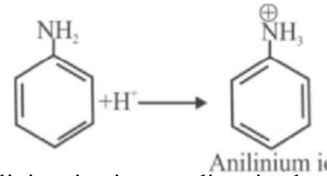


**8. Sol:**




dichlorodiphenyl trichloroetha ne (DDT)

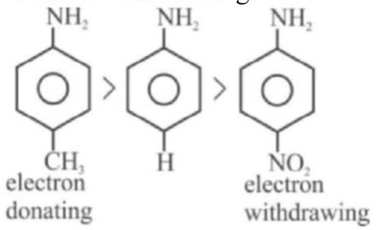
## ORGANIC COMPOUNDS CONTAINING NITROGEN

**1.Sol:** 


Anilinium ion

Anilinium ion is meta directing because $-\overset{\oplus}{N}H_3$ group is withdrawing group.

**2.Sol:** Order of Basic Strength :-

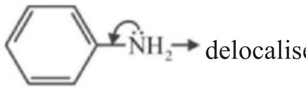



electron donating — electron withdrawing

**3.Sol:**

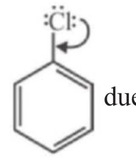
$$CH_3-\underset{O}{\overset{\|}{C}}-NH_2 \xrightarrow{Br_2/4KOH} CH_3-NH_2 + 2KBr + K_2CO_3$$

This reaction is known as Hoffmann hypobromamide reaction.

**4.Sol:**  delocalised lone pair of nirogen atom arylamine with benzene ring in aryl amine. $R\ddot{N}H_2 \longrightarrow$ lone pair of electrons of nitrogen atom are not delocalized in alkyl amine.

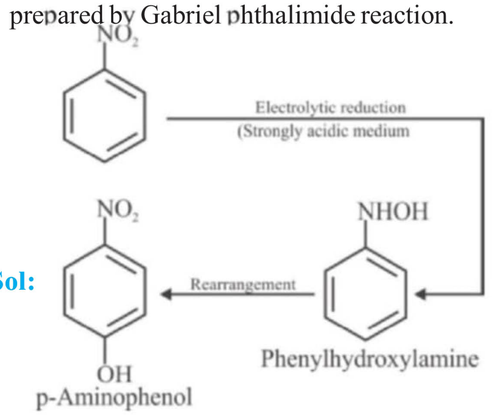
**5.Sol:** Benzoylation of amine is known as Schotten-Baumann reaction.

**6.Sol:**



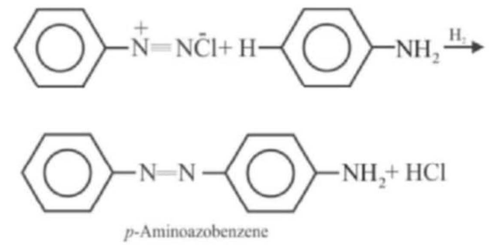
due to resonance C-Cl bond acquires double bond character. Haloarenes cannot be prepared by Gabriel phthalimide reaction.

**7Sol:**




**8.Sol:** Aromatic diazonium salts, $C_6H_5N_2^+X^-$, are more stable among the given options due to dispersal of positive charge in benzene ring due to resonance.

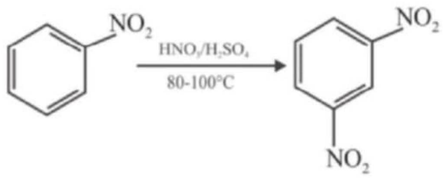
**9.Sol:**



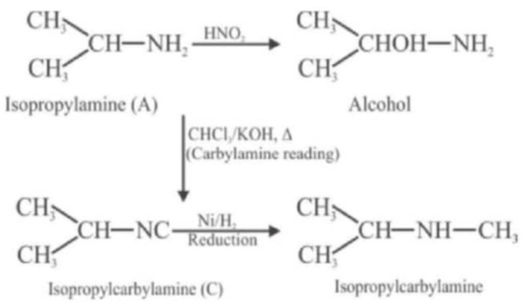

*p*-Aminoazobenzene

**10.Sol:** $H_3PO_2$ and $H_2O$ bring about replacement of diazonium chloride group by H.

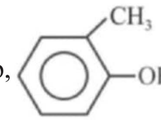
**11.Sol:** $NO_2$ is an m-directing group and hence, 1,3-dinitrobenzene is formed.




**12.Sol:** $C_3H_9N(A) \xrightarrow{HNO_2} Alcohol + N_2$ A is $1^o$ amines, i.e., $C_3H_9N$ is $C_3H_7NH_2$ Further since $1^o$ aliphatic amine (A) on warming with $CHCl_3$ and caustic potash gave compound (C) which on reduction gave isopropylmethylamine, therefore, $1^o$ amine (A) must be isopropylamine.



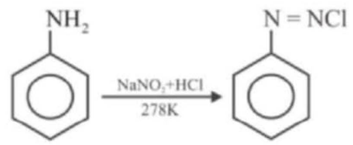

**13.Sol:** Due to the effect of +R directing influence

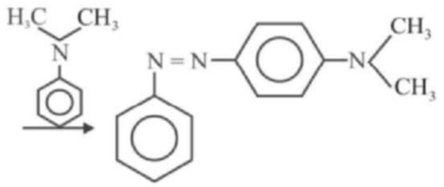



of the group, is the most reactive towards electrophilic reagent.

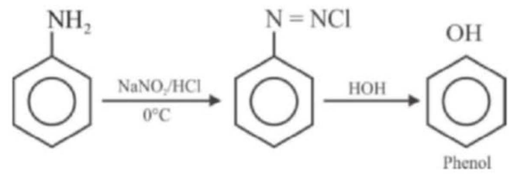
**14.Sol:** Zn dust and $NH_4Cl$ reduce nitrocompound to hydroxylamine.


**15.Sol:**

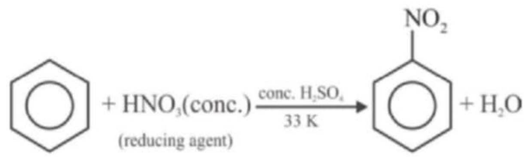


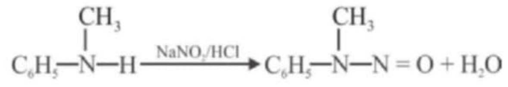

**16.Sol:**



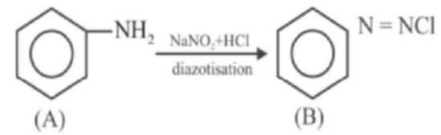

**17.Sol:**

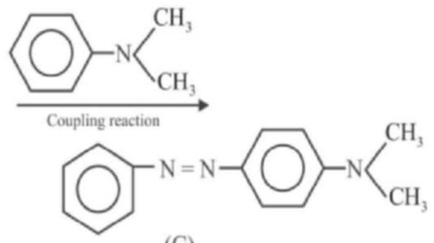



**18.Sol:**




**19. Sol:**




**20.Sol:** $CH_3NC \xrightarrow[LiAlH_4]{(C)\ H} CH_3NHCH_3$



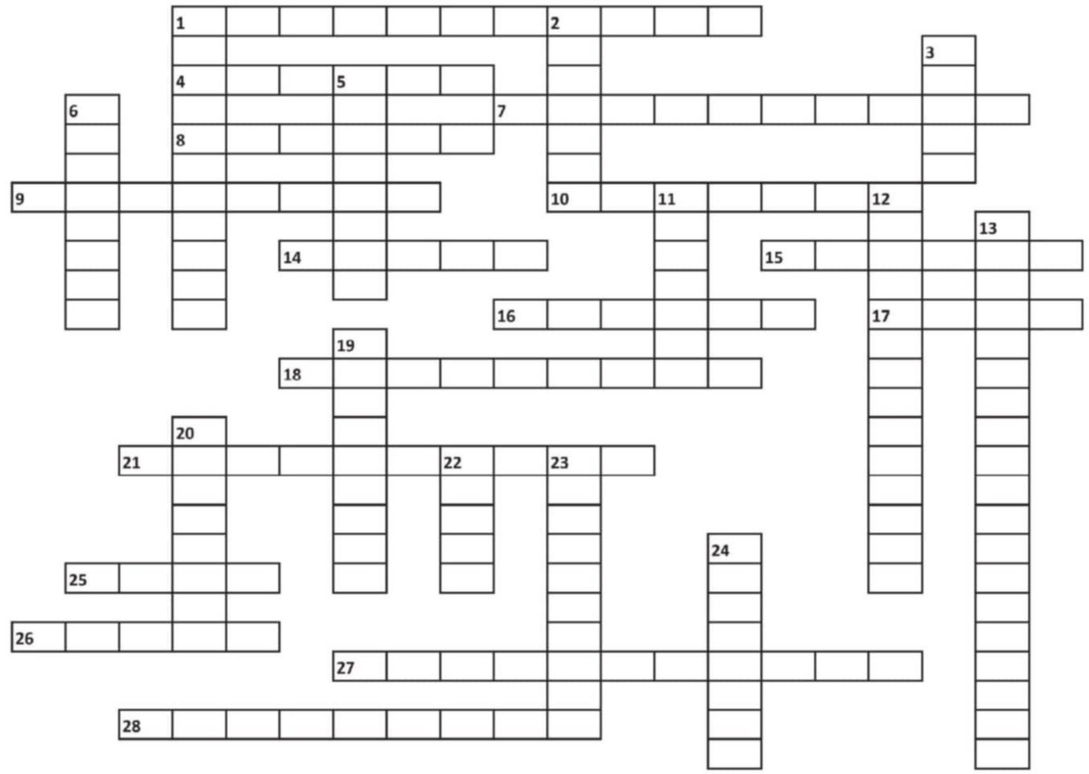


# CROSS WORD PUZZLE

**Inorganic (4)**

**By:** Arup kumar chakravorti (Kolkata)

**I.**




## Across:

**1.** The process by which hydrate oxides or hydroxides and carbonates converted into respective oxide.(11)
**4.** A substance that destroy catalyst activity (6)
**7.** A technique for making steel from pig iron, scarp steel and iron ore (10)
**8.** Neutral molecule which donates lone pair of electrons to the central metal ion. (6)
**9.** A process by which pure Ti & Zr are obtained (8)
**10.** Radioactive silvery metal which turnishes black in air and it's have no reaction.(7)
**14.** $Pt/PtO_2$ catalyst.
**15.** The mixture of $Ca_3P_2$ and $CaC_2$ in used for ..... (6) signal.
**16.** A method used for purifing metal (6)
**17.** Hydrated silica used as gemstone (4)

**18.** $[Co(NH_3)_3Cl_3]$ can shows .....(9)
**21.** A mixture of $CaCO_3$ and $NH_4NO_3$ (10)
**25.** When flux reacts with impurity ..... (4) is formed
**26.** Natural $Fe(OH)_3$ containing $MnO_2$ (5)
**27.** Silicon carbide. (11)
**28.** Mineral name of $VS_4$ (9)

## Down:

**1.** Ag in purified by the method .....(11)
**2.** When tin changes silvery. $\beta$ – form to gray $\alpha$ – form . (7)
**3.** Periodic acid is known as .....(5) acid
**5.** Kelp (8)
**6.** These are complex ions which are formed metal ions and water molecules (8)
**11.** $(Mg^{2+}, Fe^{2+})_2SiO_4$ (7)
**12.** $Mg(OH)_2$ is used as antacid (14)
**13.** $H_2PtCl_6$ (19) is ..... acid
**19.** $Na + C_5H_5^{\ominus} + FeCl_3 \rightarrow$. 'x' is ..... (2)
**20.** $BCl_3 + LiALH_4 \rightarrow M + LiCl + AlCl_3$; M is ..... (8).
**22.** $BrClF_2C$ is called ..... (5)
**23.** $ZnS + BaSO_4$ is called .....(10)
**24.** The process of purifing substances from mixture (8)

*Solution to the above puzzle will be published in the October month issue.*

# Fun and Interesting Facts

1. *J is the only letter that does not appear on the periodic table.*
2. *Bones, teeth and pearl will dissolve in vinegar because it contains weak acetic acid.*
3. *The amazon rain forest produces approximately 20% of the oxygen in the atmosphere.*
4. *The surface of mars is red because of the presence of iron oxide.*
5. *Helium can be frozen only through pressure not by cooling.*
6. *Hydrofluoric acid is corrosive that it can dissolve glass.*
7. *Your tooth enamel is the hardest chemical substance in your body.*
8. *DNA does not catch fire.*





# CHEMIS TRICKS

**By: A.N.S. SANKARA RAO (Hyderabad)**

## ELLINGHAM DIAGRAM

H.J.T. Ellingham has given a graphical representation, that shows the variation of $\Delta G$ (Gibb's energy) with increase of temperature for the oxidation of metals into their oxides.

$$2x\,M(s) + O_2(g) \rightarrow 2M_xO(s)$$

This diagram helps us in predicting the feasibility of thermal reduction of oxide ore (by selecting the best reducing agent). This could be possible by understanding some of the most significant thermodynamic principles of metallurgy like $\Delta G$. The main purpose of metal industry is to cut expenses by maintaining low temperature to reduce the metal oxides with the suitable reducing agents.

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$
$$-\Delta G^\circ = -RT \ln K$$

For the feasibility of the reaction $\Delta G^\circ = -Ve$, this is possible if $\Delta H^\circ = -Ve$, $\Delta S^\circ = +Ve$. But $\Delta H^\circ < T\Delta S^\circ$ ($\Delta G^\circ$ becomes - Ve after certain temperature). The role of the reducing agent is to make the sum of $\Delta G^\circ$ values of the 2 reactions (oxidation of the reducing agent and reduction of the metal oxide) negative.

### Main features of Elingham diagram:

- With the rise in T, straight lines (most of the ) slopping upwards (due to rise in T)
- Oxides at the bottom of the diagram below ($\Delta G^\circ$ = high -Ve) are highly stable, at the top are least stable, which does not require any reducing agent, can decompose easily ($\Delta G$ = +Ve , oxide is unstable)

$$2Ag_2O \xrightarrow{\Delta} 4Ag + O_2$$
$$2Au_2O \xrightarrow{\Delta} 4Au + O_2$$
$$2HgO \xrightarrow{\Delta} 2Hg + O_2$$

- Each plot in Ellingham diagram is a straight line (except phase change i.e., solid $\rightarrow$ liquid or liquid $\rightarrow$ gas )
  eg: Zn & ZnO plot, the melting is indicated by abrupt change in the curve.
- Reduction process is more efficient when the gap between 2 curves is more.

**CHEMISTRICK: A METAL (or non metal or non-metal oxide) found below in the Ellingham diagram can reduce the metal oxide lie above it.**

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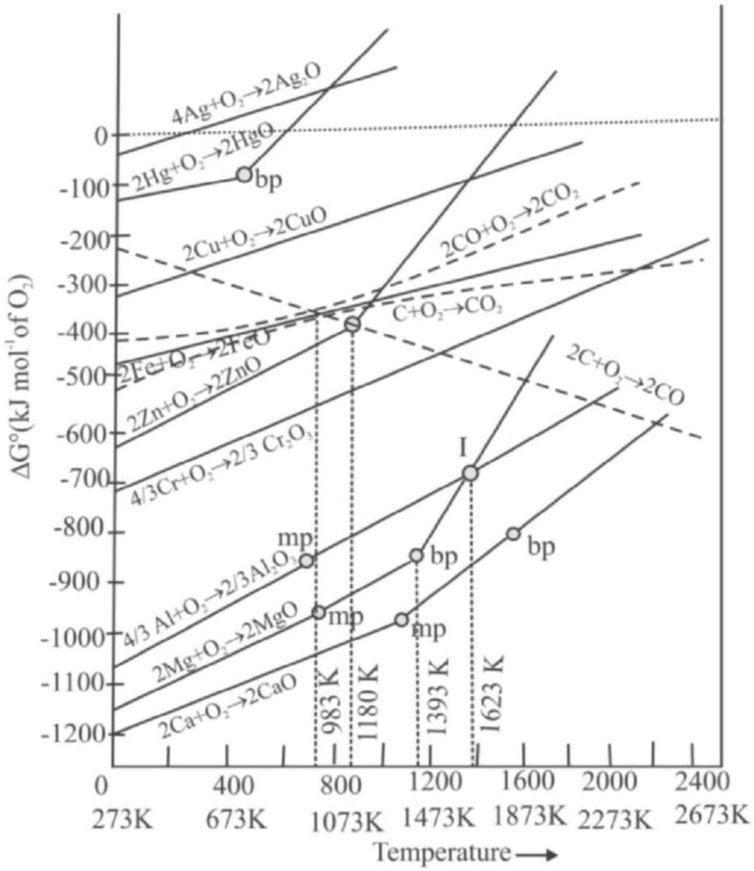



**Fig. Gibbs energy change ($\Delta_f G^\circ$) vs T plots for formation of some metal oxides (Ellingham diagram)**

**Relative stability of metal oxides:**

$CaO > MgO > Al_2O_3 > Cr_2O_3 > ZnO > Fe_2O_3 > HgO > Ag_2O$

**CHEMISTRICK:** Mr. Camagal (Ca,Mg, Al) Crazy for iron (Cr, Zn) (Fe) cup (Cu) made by mersil (Hg, Ag) company

- In blast furnace, the reduction of $Fe_2O_3$ takes place at different temperatures.
  - Below 983 K temperature "CO" can reduce haematite ore into iron easily.

$$Fe_2O_3 + 3CO \xrightarrow{< 983K} 2Fe + 3CO_2$$

  - Above 983K temperature C (Coke) can reduce haematite easily ($\because Fe_2O_3$ has high $\Delta G$ than that of coke)

$$Fe_2O_3 + 3C \xrightarrow{> 983K} 2Fe + 3CO$$

- ZnO can be reduced by CO and C. But ZnO can be reduced by coke only above 1273 K

$$ZnO + \underline{C} \longrightarrow Zn + CO \quad (\checkmark)$$

$$ZnO + \underline{CO} \longrightarrow Zn + CO_2 \quad (\times)$$

To select the best reducing agent among C & CO for ZnO, let us examine the curves of $CO \to CO_2$, $C \to CO_2$ and $C \to CO$.

**I.** $2C(s) + O_2(g) \to 2CO(g)$

Here the plot goes downwards (-Ve slope)

$\Delta n_{(g)} = n_p(g) - n_r(g)$

$\Delta n_{(g)}$ = no. of moles in gaseous state

$n_p(g)$ = no. of moles of products in gaseous state

$n_r(g)$ = no. of moles of reactants in gaseous state

where $\Delta n_{(g)} = 2 - 1 = 1$

If no. of gaseous molecules increases randomness $(\Delta S)$ increases $(\Delta S = +Ve)$

$\therefore$ $T\Delta S$ is +Ve ($\because$ T & $\Delta S$ increases)

Hence $\Delta G = -Ve$ (decreases), reaction becomes spontaneous.

**II.** $C(s) + O_2(g) \to CO_2(g)$

Here the plot is parallel to temperature axis

Where $\Delta n_{(g)} = 1 - 1 = 0$

as no change in the number of molecules, $\Delta S = 0$ & $\Delta G = 0$. Hence increase of temperature does not effect the reaction.

**III.** $2CO(g) + O_2(g) \to 2CO_2(g)$

Here the plot goes upwards (+Ve slope) where $\Delta n_{(g)} = 2 - 3 = -1$ as the no. of gaseous molecules decrease.

$\Delta S = -Ve$ (decreases) & $T\Delta S = +Ve$

$\therefore$ $\Delta G = +Ve$, the reaction becomes non-spontaneous.

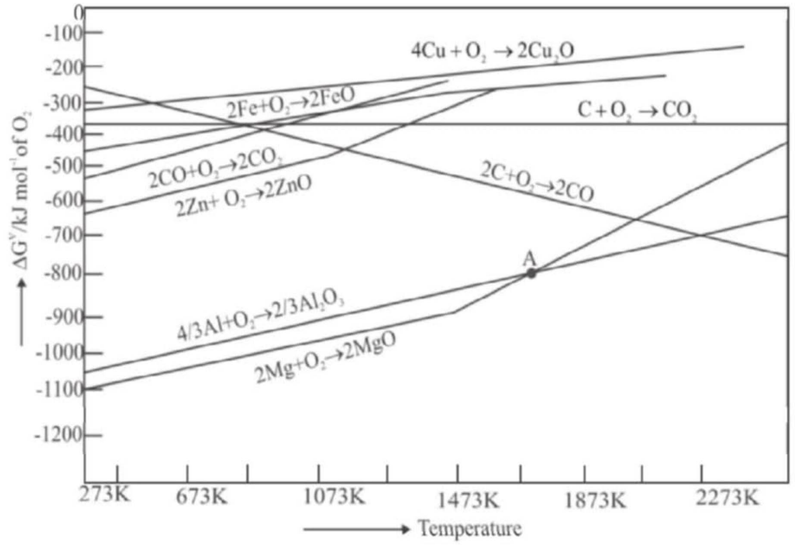
Now you can say that coke is the best reducing agent to reduce ZnO. Because $C(s) + O_2(g) \to CO_2(g)$ curve is horizontal to temperature axis, so $\Delta G = 0$. Reaction is spontaneous only if $\Delta G = -Ve$.

- Intersection of the $Al_2O_3$ and MgO curves found at point A. Below this point (A) Mg can reduce alumina but this process is un economical, above this point (A), Al can reduce MgO.
- Al can not reduce MgO to Mg below 1623 K but Mg can reduce $Al_2O_3$ to Al.
  - Below 1623 K, MgO is stable so Mg can reduce $Al_2O_3$ to Al.
  - Above 1623K, $Al_2O_3$ is stable so Al can reduce MgO to Mg.

**Limitations of Ellingham diagram:**

- It does not predict the kinetics of the reaction.
- Interpretation of $\Delta G^\circ$ is based on equilibrium constant (K) $\Delta G^\circ = -RT \ln K$.

It is assumed that both the reactants and the proucts are in equilibrium this is always true as the reactants or products may be in solid state.



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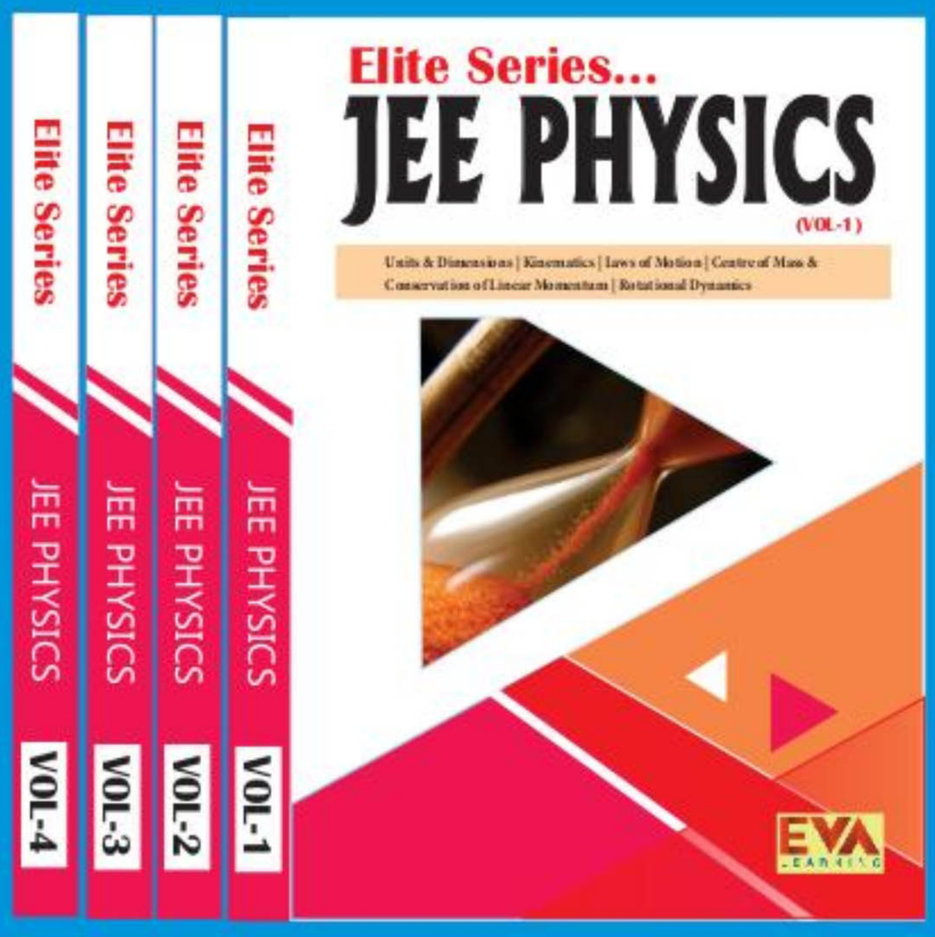


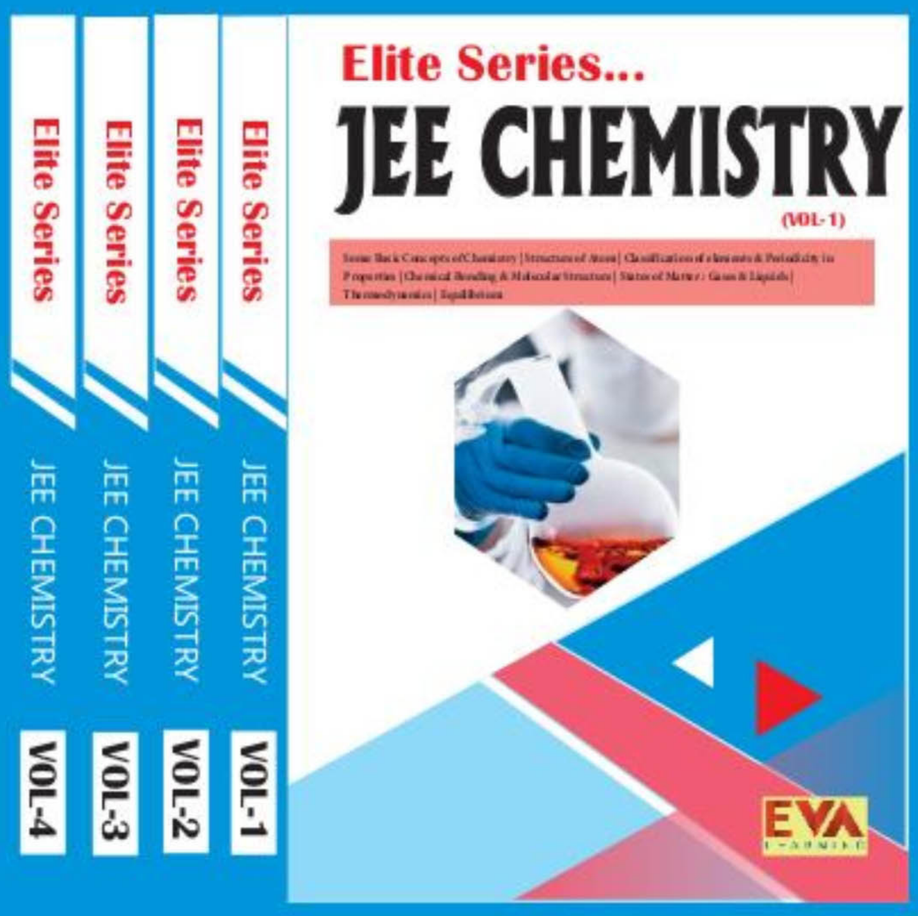


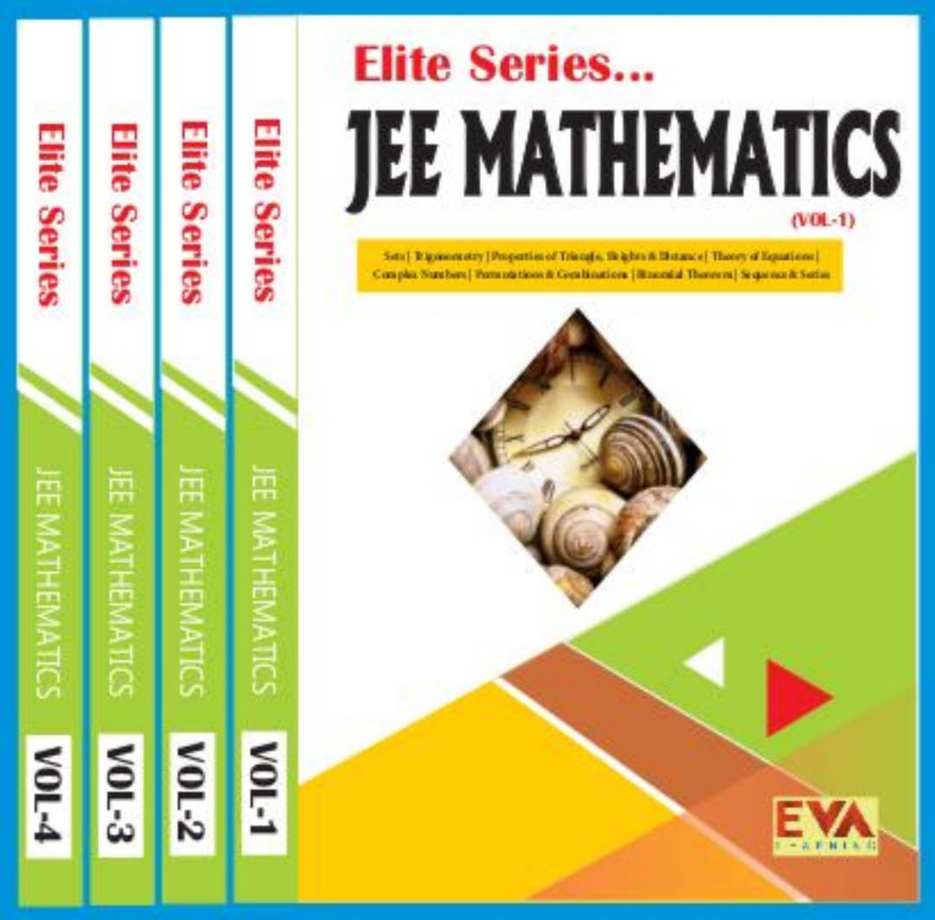


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